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# THE CONDOR

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# THE CONDOR

VOLUME 60

MAY-JUNE, 1958

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## TERRITORIALITY AND BREEDING BEHAVIOR OF A POPULATION OF BLUE GROUSE IN MONTANA

By JOHN L. BLACKFORD

Recent investigation of a forest-dwelling population of Blue Grouse (*Dendragapus obscurus*) in northwestern Montana has disclosed significant new facts concerning the life history of the species. Distinctive features of the nuptial display, wing notes, hooting habits, and territoriality of breeding males were observed. These features provide a definite basis for comparison with the characteristics and behavior of the coastal races. This study was begun when close-range encounter with a courting male revealed a display of unusual interest. Behavior patterns, previously unreported, were noted as investigations were continued through the season. As a result, it was possible to obtain a clear outline of the territorial relations and social structure of this breeding population.

### ACKNOWLEDGMENTS

I am indebted to Alden H. Miller for helpful suggestions in the preparation of this report. The following manuscripts were kindly made available: Caswell, E. B., "A Preliminary Study of the Life History and Ecology of the Blue Grouse in West-central Idaho," University of Idaho thesis, 1954; Schottelius, B. A., "Studies of the Blue Grouse . . . in the Methow Valley of Washington," State College of Washington thesis, 1951. I wish to thank Dr. L. C. Cady and Dr. Paul D. Dalke for their generous permission to quote from these manuscripts and I would like to express my appreciation to Mrs. Robert F. Herrig, Librarian, Lincoln County Free Library, Libby, Montana, for securing the manuscripts for me through interlibrary loan.

### AREA DESCRIPTION AND STUDY PERIOD

The study area in Montana (fig. 1) is a forested ravine and its enclosing slopes which lie on the upper, south-facing front of the Purcell Range. It is between Canoe Gulch to the west, and a high, flanking ridge descending to the southeast. The Kootenai River flows around the extended lower spur of this ridge to form the Big Bend in the Kootenai in central Lincoln County. This steeply ascending draw heads out at a saddle on the sharp shoulder of the mountain at about 4300 feet elevation. In its upper portion, two run-off channels, the wooded "west ravine" and the more rocky "east gully," separated by a low dividing ridge, form the narrow, descending floor of the depression to a point about midway in its course. Below, the west ravine continues down slope as the single, summer-dry drainage channel. It receives also the overflow rill from a seepage pool situated in mid-ravine close to the eastern hillside.

The lower ravine is marked by the widely parted walls of the draw and by its own broad, down-slanting floor. Half-way down the mountain front, at about the 3200-foot level, the ravine becomes shallow and is lost as a surface feature.

Mixed yellow pines (*Pinus ponderosa*) and Douglas firs (*Pseudotsuga taxifolia*) forest the floor and slopes of this little canyon. Grassy openings frequently break its arboreal cover. Aspen (*Populus tremuloides*), in scattered groves, mingles with the conifers in the deeper parts of the draw and is found on moister sites at the lower levels.

Thickets and scattered undershrubs, wild rose (*Rosa*), snowberry (*Symphoricarpos*), serviceberry (*Amelanchier*), and chokecherry (*Prunus*), together with balsam root (*Balsamorhiza*) and a wide variety of other forbs and grasses, carpet the area. Logging 12 years ago created minimum disturbance due to selective practices and limited cutting of trees and it has been followed by more than a decade of recovery.

In the spring of 1957, nine trips were made to the ravine, on April 16, 20, 22, 30, May 9, 15, 23, June 1, and 3. A total of 40 hours and 55 minutes was spent there, of which 21 hours, or 51.2 per cent, were occupied in close-up observation of displaying Blue Grouse. My earliest morning arrival on the area was at 8:30 a.m.; the earliest observation of a male bird was at 9:51 a.m. The latest evening observation was at 9:05 p.m.

#### IDENTITY AND TERRITORIAL LOCATION

Three breeding males occupied the ravine. At first my attention was centered on courtship display, but I soon became aware of individual identity and territoriality in these grouse. The displaying birds were designated males A, B, and C, and they occupied territories 1, 2, and 3, respectively. From May 9 on they were sought and successfully located entirely on the basis of this classification. No male was seen at any time on the territory of another except on April 22, 1957, when apparently the entire population was gathered in communal display on the lower west slope. Except for this occasion, each male was found and observed only on his own limited territory. Attendant female grouse were less approachable in the courtship period, and their number was not clearly determined. They were observed at intervals, but little attention was given them except in relation to the calling and courting of the males.

Male A, the first grouse seen, was a large grouse in rather light plumage. He displayed a perfect tail fan, a feature that at once distinguished him from other males in the area. This bird was notable for an uncommonly confiding nature and tolerance of close approach. At times he came voluntarily to within 6 or 7 feet of me, and, although often pressed closely, he never took wing except to fly into his roost tree at dusk. Male A was first encountered displaying among the open pines of territory 1. This plot, approximately 400×500 feet, included the eastern portion of a dense pine-fir stand on the floor of the lower ravine. From there, it extended up the semi-arid, pine-clad slope of the eastern ridge to rock slides and outcrops along the slanting summit. A game trail traversed the lower section, leading to the seepage pool and upper ravine. Male A was observed on territory 1 as follows:

April 16 (4:50-6:00 p.m.) 1 hour and 10 minutes; May 9 (3:37-4:30 p.m., 5:30-5:45 p.m.) 1 hour and 8 minutes; May 23 (8:12-8:51 p.m.) 39 minutes; June 1 (3:32-9:05 p.m.) 5 hours and 33 minutes; June 3 (3:40-7:00 p.m.) 3 hours and 20 minutes. Total observation time: 11 hours and 50 minutes. Male A was sought briefly but not found on April 20.

Male B, the occupant of territory 2, was a bird of medium size, somewhat darker than Male A. He was clearly marked by two short replacement tail feathers on the right side. These two adjacent feathers were about 1½ inches shorter than average. Male B was an energetic individual. When he was on the ground he was not tolerant of an approach closer than 30 to 40 feet. At that distance, he was indifferent to an observer and engaged in every normal activity. If approached too closely, he hurried away on foot. While flying, he made no effort to avoid me and occasionally came closer to me than he did while on the ground. Traveled on the ground for hours to all parts of his territory, he kept at a distance but he seldom took flight except to follow the hen. In only one instance did flight lead off his territory; on April 22, two birds from this territory were followed down the draw, where communal display was observed.

Territory 2, 400×600 feet, was a rather densely forested plot. It encompassed the



upper ravine, reaching from just above the seepage pool to a hundred paces below the high divide. At its upper limits the sloping walls of the draw converged, the ground there rising steeply to the saddle. Pine and fir, broken by grassy openings, ascended the ravine. Thickets of saplings partly filled its eastern gully; over the rounded dividing ridge on its slanted floor, taller firs were clumped in pure stands that became open near the summit of the mountain. Male B was observed on territory 2 as follows:

April 20 (4:23-4:33 p.m.) 10 minutes; April 30 (9:51 a.m.-3:05 p.m.) 5 hours and 14 minutes; May 15 (4:40-6:58 p.m.) 2 hours and 18 minutes. Total observation time: 7 hours and 42 minutes. On April 22 Male B was identified but was not on his territory.

Male C, a frequent drummer, appeared to be a darker, larger bird than Male B. He could be identified by one short tail feather on each side of the fan and several other tail feathers of irregular lengths on the left side of the fan. This male seemed rather wary but showed indifference to me at the height of courtship display when he was near the hen. His strutting ground was on the lower hillside of territory 3, a large irregular area estimated at 600×800 feet. Lying on the broad floor of the lower ravine, his territory extended up the western slope to include extensive open pine woods. It was not as well defined as the other two territories. This was due both to a wider separation of its vegetational components and to a briefer investigation of its occupant and his movements. The territory included the west portion of the pine-fir stand adjoining territory 1 and was separated from it by an old logging lane through the timber. From that point the territory spread across the floor of the draw, covered with low brush, to ascend the west hillside. On the southern or drainage side the apparent limits included an isolated stand of conifers. The edge of the heavier forest, descending from mid-ravine, bordered the plot on the north. From the west slope, there was a clear view across to the face of the east ridge opposite and the upper portion of territory 1, 250 yards away. Tall antelope brush (*Purshia tridentata*), serviceberry, and abundant balsam root gave portions of the slope increased cover, making the location of a displaying or even drumming bird difficult. Male C was observed on territory 3 as follows:

April 22 (5:10-5:25 p.m.) 15 minutes; May 9 (6:03-7:15 p.m.) 1 hour and 12 minutes. Total observation time: 1 hour and 27 minutes. Male C was sought on June 3 but not found although drumming could be heard. Drumming on three additional dates also indicated that a male Blue Grouse was stationed on the plot.

Investigation of territories 1, 2, and 3 always revealed one or more of the males on home ground. Failure, in a few instances, to locate an individual on his territory did not prove the absence of the bird. As hooting declined, the search for silent birds became a problem. Only a knowledge of the territorial behavior and individual habits of the three male grouse made later surveys of this well-wooded area successful. The three territories were seldom checked on the same day because a resident bird, when found, was usually followed for the remainder of the visit. Territorial borders were inferred from movements of individuals, the concentration and nature of their activities, and the distribution of vegetation. No territorial defense was observed. However, "territorial drumming" was noted throughout the course of the study.

#### TERRITORIALITY

Territoriality in breeding male Blue Grouse is an aspect of behavior that, with increasing information, is assuming greater significance. Study of territoriality facilitates comparison between the racial groups within the species and provides information on the habitat relations required for the solution of problems in wildlife management. Territoriality in the Pacific coastal Sooty Grouse, or *julginosus* group of *Dendragapus obscurus*, appears well authenticated (Bendell, 1955:369; Hoffmann, 1956:327). Studies

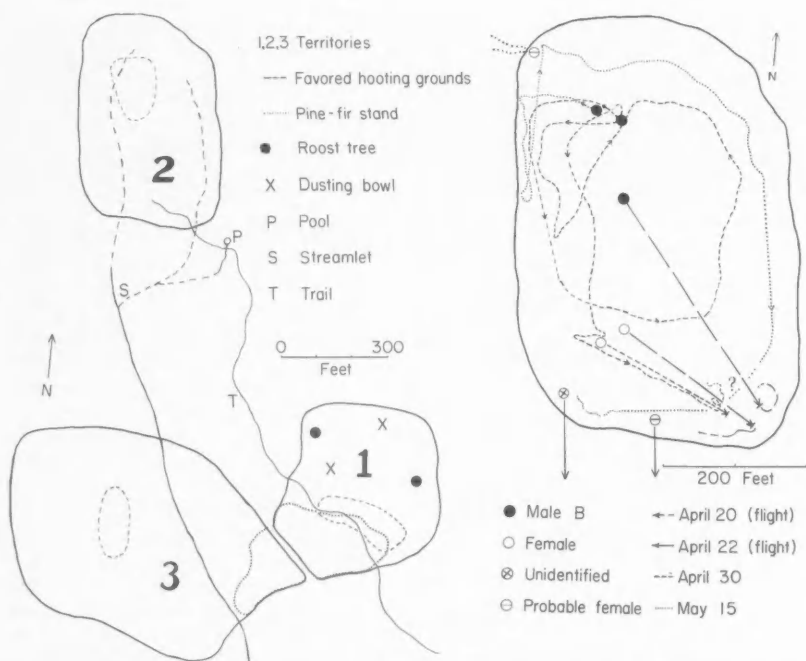


Fig. 1. Left: diagram of south front of Purcell Range, central Lincoln County, northwestern Montana, showing breeding season territories of male Blue Grouse in spring of 1957. Right: diagram showing movements of Male B on territory 2, April 20, 30, and May 15, 1957, and off-territory flight of two unidentified Blue Grouse on April 22.

of the interior Dusky Grouse, or *obscurus* group, occurring in the Rocky Mountain and Great Basin regions, have been less representative. Present reports deal only with breeding populations of the race *D. o. pallidus* occupying unforested sites. A tendency toward communal display, with no obvious territoriality, has been noted in Dusky Grouse on open summer range (Schottelius, MS; Caswell, MS). However, the vast montane coniferous forests of the interior, more open in character generally than those of the coastal areas, must be regarded as the metropolis of the Dusky Grouse. No major disparity is to be expected between the territorial habits of the two racial groups, both of which are essentially forest and forest-edge dwelling forms. Observations of the birds of the Purcell Range support this view. They show that, while the tendency toward communal display is indeed evident in this timber-dwelling population of Dusky Grouse, solitary display is more typical. In addition marked territoriality in both breeding behavior and daily activities is definitely indicated.

**Routine daily activities.**—Many routine activities of Blue Grouse were recorded in the course of this study. The everyday living pattern of each male was followed entirely on the bird's own territory. Male A may have sought water by short, off-territory flights to the seepage pool, but this is not definitely known. He was seen to take 14 identified food items, and many others, while foraging on his limited, yet apparently adequate

area. Feeding, resting, dusting, roosting, and other usual pursuits might all be observed on a single trip to the ravine.

With the warm days of late May and early June, there was a marked decline in nuptial activities. This was accompanied by increased feeding and lengthy intervals of leisure and rest. The cool shelter of two outlying evergreens on the north border of the lower wood, the scattered shade of groves on the pine slope, and an isolated, heavily branched fir on the higher rock slides were stations favored by Male A in late spring. At 4:10 p.m. on June 1, after 38 minutes of foraging in an area bordering the pine-fir stand, this male moved uphill on a northerly course. He progressed about 150 yards in three hours while foraging, preening, hooting, and displaying. In the evening, a rock slide and brush opening of the upper ridge, where the sunlight lingered, proved attractive. A rest period of 1 hour and 5 minutes there was followed by 43 minutes of occasional leaf-foraging and brief pursuit of insects. Time was spent in further preening, wing stretching, and "dozing." At 8:57 p.m. he had partly retraced his track along the slope and sought his roost. An immature yellow pine, standing at mid-slope near the eastern border of territory 1, was utilized by Male A as his roost on the evening of May 23. A fir, clumped with two yellow pines on the edge of a pine wood and slide rock opening along the western side of this plot, served as his shelter for the night of June 1.

By June 3, the bites of flies of the deer fly type and the bird's scratching for relief had made the base of Male A's upper mandible slightly bloody. Toward evening he hastened along the pine slope to a dusting bowl on an upper game trail and took a dust bath. Another such bowl was located beneath the low-spread boughs of the big evergreen on the upper slides.

Residence on territory, judging by observation and the facility with which this bird could be located, seems to have been continuous. Moreover, at the time he was first found on April 16, this male had already been in sufficiently lengthy possession of his territory to have attracted a hen. Similar routine activities of occupant males were observed on the other two territories.

#### BREEDING BEHAVIOR

Breeding behavior, together with related territorial organization, revealed the outlines of the social structure of this population of Blue Grouse. It was marked by disclosures of unusual interest concerning communication media, display characters, and the relations between the sexes.

*Calls.*—To appreciate breeding season activities in the ravine, it is advisable to clarify the terminology used to describe the vocal characteristics of Blue Grouse. "Hooting" commonly refers to the series of five or six notes of the calling male. This is low-toned in the Dusky Grouse and resonant and far-carrying in the Sooty Grouse. "Multiple hoot," the term employed by Caswell (MS), refers to this type of hooting specifically. Not all of the notes in a series may be audible in the case of the *obscurus* group, and there are some indications of individuality in rendition. The loud single note, *oop!* (as phoneticized by Brooks, 1926:281) is termed here the "display note," since it climaxes the full display of the courting male. Other calls heard were as follows: *Kut-kut-kut*, an alarm and warning note of two or more syllables, often extended to a series. This is given by both sexes. *K-r-r-r-r-r*, a low warning note which is voiced by a hen before flight. *Kutter-r-r-r-r*, a high, racketing, excitement call, long continued, wavering, and fluctuating greatly in pitch. This is given by the hen.

*Wing notes.*—No distinction appears to have been made among the wing notes of the Blue Grouse, and apparently only one—wing drumming—has been described. Three

very definite forms of this medium of communication and expression were utilized by the forest-dwelling birds at the Purcell Range site:

**WING FLUTTER.**—A brief flapping of loosely beating wings as the grouse rises 8 to 10 inches into the air. Although it lacks the power of display drumming, the sound still carries very well. Usually this is an arrival, location, or response signal. It is performed mostly by the hen but may be made by both sexes on the ground or in trees.

**WING DRUMMING.**—The usual drumming display flight. It is given as the male springs about three feet in the air, "hangs" momentarily on swiftly beating pinions and then descends. Variations, with the bird rotating before descent, have been described (Wing, 1946:154). This is performed as an individual display or enacted during communal courtship.

**WING CLAP.**—Similarly enacted by the male in an upward aerial leap. It is a single, sharp, very loud wing note. This was observed once; it was given from a log in excited response to the flight of a hen from a male's courting ground.

The volume and modulation of wing beat in take-off and flight, and sometimes in flight approach, also appear to function as means of communication.

**Hooting stations.**—Ground level hooting, accompanied by display, occurred at all points of a territory in the ravine. Nevertheless, a preferred strutting area of limited proportions seems to have been selected by each hooting bird, and from it the more intensive hooting was done. Similar vegetation distinguished all three strutting areas. They were in forest-edge situations that combined grassy, open, narrow forest border, and a dense conifer stand. Occasional rocky outcrops or ledges were found in the openings, and old logs were present on the deep-shaded forest floor. Any of these, or the openings themselves when the sun was not too strong, served for display. The principal variation was on territory 3 where the grassy, shrub-dotted, hillside floor of a tall pine grove provided the available "opening" farther from dense forest shelter.

**Arboreal hooting.**—For many years the reported behavioral differences between the racial groups of the Blue Grouse have influenced their taxonomic treatment (Hoffmann, 1956:321). Although morphological intergradation between them has now been described, and the taxonomy of the Blue Grouse rests on that fact, the differences in behavior between these groups are still important when comparing the coastal and interior forms on a broad biological basis. Consequently the validity or extent of these dissimilarities requires re-examination. Specifically, the belief expressed by Brooks (1926:282, 286), and presently held, that courting males of the *obscurus* group invariably hoot from the ground, is subject to correction.

It has long since been reported (Edson, 1925:228; Johnson, 1929:292) that the tree-hooting Sooty Grouse may occasionally digress from its usual behavior and hoot from ground level. Wing (1946:157) cast some doubt on the supposedly rigid adherence to terrestrial hooting in the Dusky Grouse, but no instance of departure from this habit was given.

Arboreal hooting by Dusky Grouse referable to the race *richardsonii* has been observed in the course of this study. My records show a marked tendency on the part of this representative of the *obscurus* group to vary from its supposedly typical behavior in the selection of a hooting site. On four occasions in the Purcell Range ravine, grouse were seen to hoot from trees. This activity was usually accompanied by, or alternated with, partial display, and two of the three males were involved. As the nature of these four occasions differed, and so that proper evaluation may be made, two instances are included as described in my field notes:

April 20, 1957. At 3:55 p.m., a female Blue Grouse flushed into a yellow pine. I kept her in sight from the low ridge on the floor of the upper ravine. After 20 minutes she flew down into mid-level

branches of a denser pine grove around the spring pool. I then climbed from the grassy opening of the ridge over toward the west "run" of the draw, and into immature Douglas firs. Had gone but 2 rods and only a few yards within the fir stand, when I heard hooting of a male grouse. No displaying bird was in sight on the ground, but the full-toned hooting seemed near at hand. Moving on a few paces, examining the trees, I turned east, up-slope toward the crest of the dividing ridge. The hooting was repeated, and I quickly saw a Blue Grouse [Male B] crouched on the fork of a limb, 12 feet up in an 8-inch (d.b.h.) fir. The performer was only 30 feet away and facing me. His wings were at sides, the tail but little fanned. With glasses, the combs showed a narrow, yellow curve over either eye, and the deep reddish-purple air sacs were moderately dilated. As he nodded, their white feather rosettes were half flared, while he continued hooting at frequent intervals.

I circled uphill for a side view, moving to within less than 25 feet. The grouse was perched about 2 feet from the treetrunk. Growing accustomed to my near presence, he resumed hooting; and fanned his tail to a quarter circle, tilting it a little forward over the back. The neck was considerably inflated. The eye wattles were now dull red, though but slightly distended.

The Blue Grouse faced the fir trunk, stepped to it along the branch; then out a similar distance on a lower bough. He hooted several times, and moved toward the branch tip. Near its limber end, he took off in swift downhill flight in the direction taken by the hen. At once, from above the spring, a high, racking *kutter-r-r-r*-ing call echoed at length through the timber. [This bird was under observation for ten minutes and the hooting was as loud as that heard at any time in the breeding season.]

May 23, 1957. At 8:27 p.m., when the big Blue Grouse of the eastern slope [Male A] reached the blackjack yellow pine, he flew with loud whirr of wings to a bough 12 feet up on the west side. I moved uphill from the pine, about on a level with and 25 feet from him. The grouse stepped out among the needled branchlets to feed on flower buds. He interrupted feeding to hoot—several series, some of them counted at 5 beats, and fairly audible, given with little display.

Returning along the bough, the Blue Grouse spiraled upward around the treetrunk, hopping from branch to branch. He paused at intervals to eat vigorously, cleaning out several clusters of the dark red cone flowers and pecking at staminate buds also. Continuing upward, the big, light-colored male often fanned his tail. To a quarter fan at times, lifted forward and tilted to one side. Further hooting was interspersed with feeding. Often it was barely heard, or else inaudible. Yet there was the usual pumping of air sacs, accompanied by partial display when the bird perched near the pine trunk; or muffled hooting with no display out among the limber side branches where he fed on cone flowers. Pulsation of the gular sacs was pronounced and plainly visible, the neck pockets being well exposed, although their feather rosettes were not broadly extended. At 8:37 p.m., 30 feet up in the pine, the grouse settled on a large limb facing me, and his own length from the treetrunk. There he hooted for a time—7 or 8 series of low notes, at 15- to 20-second intervals, not audible at 12 yards, or just barely so.

It was now early dusk. Male A went farther out on the same limb and was seen as a silhouette among the needle clusters. He flew to a spreading branch above, moved to a lateral fork among overhanging branchlets, and at dusk (8:51 p.m.) had gone to roost. [Much ground level hooting is likewise low in volume and sometimes inaudible at close range. It is similarly interspersed with display and other activity. Tempo increases, volume increases, and tone ranges higher when a male is calling to or courting a hen.]

The use of arboreal hooting sites by the Dusky Grouse appears to represent a continuation of normal terrestrial activity, rather than a definite seeking of trees as hooting stations. The ground level pattern of courtship display, while dominant in the *obscurus* group, seems to be in no way fixed or restrictive. The urge to hoot is persistent and is evidenced throughout the range of diurnal activities at this season. Even interruption by a potential enemy may not suppress it. If disturbed on the ground, at least limited display may again be indulged in after the bird has found safety at higher levels in trees. When the advent of the observer is not viewed with suspicion, or if his presence has been accepted, hooting and display, in a measure consistent with the elevated site, may readily coincide with other arboreal activity.

The different type of hooting site selected by the Sooty Grouse, together with its far-

carrying vocal efforts, would appear to have developed in conformity with a denser forest habitat, within the borders of which the *fuliginosus* group makes its home.

*Territorial drumming.*—Whether it was territorial or communal, drumming had social implications in this population. Through records of frequent performances, and by accompanying Male A, it became apparent that in the late afternoon this bird habitually moved up through the open pines of the eastern ridge and from its slope, toward evening, responded to the wing drumming of Male C from the western hillside opposite. Similar movement by the latter from the floor of the ravine was indicated. On May 9, Male A also gave instant response from his ridge front station to the flight of birds which I flushed across the draw on territory 3.

A wing drum from the hillside on that territory, heard by Male A at 6:48 p.m. on June 3, caused him to stand up on the alert in his dusting bowl. He faced in that direction for many minutes with primaries stiffened and extended to the ground, flicking them intermittently. My presence apparently inhibited a more demonstrative response.

When going to roost on May 23, Male A performed a wing flutter. Facing westward from the trunk of the pine along a heavy, lower bough, the big grouse sprang 10 inches into the air and executed this softer wing note with loosely beating pinions. Descending rapidly to the branch, he stepped out to feed on flower buds of the pine. After three or four minutes, there was a loud wing drum from the west slope. It was clear that responsive or rival drumming, from opposite slopes, between males on their respective territories, marked the usual course of events during the late afternoon and evening in the lower ravine. Perhaps this was also true in the early morning.

*Display characters.*—Nuptial displays of the Blue Grouse have long received attention since they rank among the most spectacular performances of the Tetraonidae. But certain aspects of the courtship routine, such as the eye-comb display and its accompanying color changes, have yet to be reported in detail. The distensible eye combs present in this genus are perhaps the largest and most highly developed in the New World tetraonids. When erected they become prominent, extending almost across the crown of the head. The color has been described by various writers as "yellow," "orange-yellow," "dusky-orange," and "fiery red." Only Wing (1946:156) has given a brief explanation for these seeming disparities: "In *Dendragapus*, the combs are normally yellow, but they change color under stress of sexual fervor and may become bright red."

On April 16, while descending the east ridge through the open pine of the ravine, I encountered Male A in full display. During the following hour and ten minutes, it was possible to observe the bird with 8×40 binoculars from distances of 11 to 30 feet. Occasionally the bird could be watched at a distance of 8 feet without field glasses. When first seen the grouse was engaged in the usual courtship performance with tail broadly fanned and tilted forward, wings trailing, air sacs dilated, and with the white feather rosettes encircling the air sacs widely flared. At this time another startling feature was visible. The eye combs were broadly erect and were bright orange to blood red. After some minutes this color subsided to orange-yellow. The orange tinge slowly disappeared, and the combs, still fully distended across the top of the head, turned to clear, deep yellow.

As I moved to within 12 feet of Male A and he resumed his display, it was apparent that the deeper coloration first appeared along the basal strip of the eye wattles, turning them orange-crimson for their full length. Above and around the basal area, the fringe of the comb still showed lemon yellow. Rather rapidly a blood-red flush spread throughout the comb, from the base into the fringe or dilated "spikes" adorning it, until both combs became brilliant orange and then crimson. Soon this crimson suffusion receded until, within four or five minutes, the eye combs, although fully erect, were clear bright

yellow once more. The suffusion might be renewed before it had completely vanished, obviously as his excitement increased. As the color receded, the base of the comb first turned yellow, just as it had initially turned red. Then the fringe of the comb cleared, the crimson subsiding to orange and the recession of color passing out toward the tips of the short spikes, where the brighter color disappeared last.

This occurred repeatedly; yet, in spite of the approach of a hen that flew up to a nearby perch in the pine-fir stand on the floor of the ravine, the color was not so brilliant as the grouse grew less wary. I circled the male to observe the other bird. When I returned to the male, he had ceased to strut. His plumage was in its usual form. Only the eye combs were half erect and were yellow in color. By close approach, I succeeded again in inducing display. But the Blue Grouse no longer attained the degree of excitement of his earlier efforts, nor did the eye combs assume the brilliance of their first coloring.

On each of seven subsequent trips to the ravine in the active breeding period, the foregoing observations were frequently confirmed. Close-up study of Male A and the two other males afforded numerous opportunities for noting the stages of erection, as well as the diffusion and recession of display coloration, in the eye combs of *Dendragapus obscurus*.

In repose, when contracted to a narrow curve above each eye, the combs of the male Blue Grouse are overlaid and concealed by compact skin folds and feathers of the head. A yellowish, terminal, circular spot may be visible in the loreal region directly in front of the eye. Raised in limited display, or observed in the process of contraction, they arch in lines of dull yellow over each eye. Dilated moderately, in response to mild stimulation, the combs appear as slightly expanded wattles of dusky red that brighten or fade again to ochre yellow. Such lesser manifestations may be preliminaries to strutting and full courtship display, or they may mark the usual appearance of the hooting bird in the absence of further excitation.

It is evident that the eye combs in this species are equipped with a specialized vascular system and nerve supply which react to the emotional stimuli experienced by the bird. Their physiology should prove of interest.

*Courting.*—Courtship activities provided the most certain proof of territoriality among breeding males in the study area. Such activities also revealed the more important social mechanisms that lead to the meeting and mating of members of this population.

On April 30, hooting was a chief occupation or an almost continuous adjunct to other male activities. Male B was located by his hooting at the edge of a fir clump high in the west ravine near the head of the dividing ridge. Between 9:51 a.m. and 12:30 p.m., while I followed him leisurely, he foraged, hooted, and displayed, taking a circular course about 100 yards in diameter that circumscribed this favorite area (fig. 1). After he had returned to the spot near the head of the ridge, where he had been found strutting 2½ hours earlier, I decided to press him more closely. He proceeded once more to the west slope, and then he hooted again within a dense fir stand where he had previously performed. However, when I retreated to a distance, the hooter hurriedly paraded past me on the slope below and returned directly to the starting point. At this time, from the edge of the upper fir stand, he settled down to steady, loud hooting, with little display, continuing for more than an hour. During one period of 10 minutes, Male B voiced his five-note series at least once every 15 seconds, with the exception of one 40-second interval. A little later during a 10-minute period, this male hooted 34 times, each time giving the full series. I moved to within 25 feet of him, and he edged upward across the open space to mount a log; his steady *umphs* continued.



At 2:00 p.m., I thought I heard a light wing flutter behind me from down the ravine. This impression was immediately confirmed by the calling male which went into striking display and dropped from the log. His eye combs flushed a bright crimson; they were fringed at the tips with orange-red and were distended broadly across his crown. His hooting stepped up to five of the five-beat series per minute.

With as much strut and display as the terrain and brush permitted, the hooter circled at 60 feet and hastened down the west ravine. Twenty-five yards away, I saw him go over a low rise in the floor of the draw, and hurrying forward I quickly relocated him in a little fir grove perhaps 100 yards below his upper station. The intensity of this male's display suggested the presence close by of the hen. Moving slowly, I flushed her from beneath a nearby evergreen. She hurried into some low briars in a little depression. Male B then crossed close in front of me, tail fanned to half circle, neck rosettes flared, and eye combs fiery red. Near the hen, he made an impetuous dash at her and emitted a single, very loud *oop*. She quickly flew 40 feet up into a tall fir which was 30 yards down slope. The cock strutted on into a conifer stand and continued hooting from an old log.

Presently the hen flew 85 yards down slope into the lower branches of some tall trees at the seepage pool. Instantly Male B responded to her departing flight by springing three feet into the air from the log and giving a sharp wing clap. The effect was much like the crack of a pistol shot and was apparently produced by one powerful downbeat of the incurred pinions. Male B then paraded after the silent female. Under the trees, he courted ardently and, as when he startled her into the fir tree, sounded another loud *oop*. As I was unable to locate the hen, and since it did not appear that she would come to the ground, I left after more than five hours observation of the male within the limits of territory 2.

On May 15, at 3:56 p.m., a male grouse, thought by reason of his territorial location and style of hooting to be Male B, was heard on the upper portion of this territory. For the first time the ventriloquism of a hooter introduced difficulties. After 44 minutes of intensive effort, Male B was found displaying on a mossy outcrop at the edge of dense conifers in the upper west ravine which was his favored hooting ground. In search I had completely encircled him and had passed within five yards of his station. Soon Male B climbed the west slope to feed in the foliage of the pine and fir trees. This was the same foraging ground that he had utilized on April 30. At 5:20 p.m. two wing flutters were heard nearby along the west hillside up the ravine. Male B did not react to this demonstration; this was the first indication of a more subdued attitude in the behavior of a breeding grouse on the study area.

Alternating feeding with resting periods, Male B flew 100 feet into a pine where he fed on the staminate flowers. At 6:03 p.m. he flew back and dropped into the top of a young fir just below me. At last he peered intently along the slope in the direction from which the two wing flutters had come an hour before. At 6:20 p.m., the grouse whirled toward the head of the ravine. Another wing flutter sounded there in instant response to his flight and approach. Trailing up slope, I saw Male B in full display beneath a fir in an open grove. Being chilled by inactivity, I did not await developments but proceeded to investigate the wing notes. Soon they were repeated from scattered pines 125 yards higher on the mountain side. Search again did not disclose the performer. The entire episode reflected the shy behavior of a hen. On this occasion the hen had come to the upper borders of territory 2, and it is clear that in signaling, and waiting for an hour, she had expected to find the male in this locality.

I returned to the displaying resident Male B. He strutted down into the west ravine, over the head of the dividing ridge, and into the dense fir thickets of the east gully. From



there he flew 100 yards down the ravine, where again a Blue Grouse rose in short flight, heading back west, and keeping within the limits of the territory which the bird was believed to occupy. It was 7:15 p.m., and since mid-afternoon, Male B had nearly completed an entire circuit close to the outer boundaries of this previously delineated area (fig. 1).

At 5:45 p.m., May 9, four loud display notes were heard at short intervals coming from the west slope of the lower ravine. Similar notes followed, and wing fluttering was heard in response. I crossed the ravine floor to the foot of the slope on territory 3. The birds there became silent. Then presently from my left came repeated *kut-kut-kut* notes of warning. From my right, there was further wing fluttering. At 6:03 p.m., at the point at which the warning notes had originated, a courting grouse (Male C) was located on the ground under open pines and fir. As before, he proved wary for a time. After a futile effort to discover the source of the wing fluttering from the pines 200 feet north along the slope, I followed Male C as he displayed and hooted. He led off down the ravine, repeating his six-note series, the second note being the unemphasized beat. But quickly, at 6:49 p.m., a series of *kut-kut* warnings came from behind me. Male C ruffed his plumage in full display and immediately reversed his direction. He strutted past me 20 feet down slope. A dozen paces beyond, nearer the "hen," he sprang three feet into the air and drummed; then he returned up slope to his original station.

Returning to the slope and pine grove 75 yards away, I detected the tail of a grouse 50 feet up in a yellow pine. This bird, which had been concealed behind the tree trunk, was readily identified as a hen. Aware of discovery, she raised her crest feathers and gave several series of alarm notes and then flew 160 yards across the lower ravine into the pine-fir wood. Male C promptly followed her flight, alighting on a log at the border of the wood. He was displaying there when I departed down the draw.

Observations through the season disclosed a number of visitations or occurrences of female grouse on male territories. A hen was seen on territory 1 on April 16, and on other occasions wing fluttering was heard twice, issuing from the pine-fir wood when Male A was displaying nearby. A hen appears to have been present on the plot every time I located Male B on territory 2. Male C was actively courting a hen on territory 3 on both observation dates, and wing fluttering may have indicated the arrival of a female on a third occasion. Thus it is apparent that females regularly responded to calling, territorial males.

*Communal display.*—Trailing two Blue Grouse that flushed from territory 2 in the upper ravine at about 5 p.m., April 22, I reached the broad floor of the lower draw. At the base of the west slope, a bird, thought to be the hen from up ravine, rose again and flew far over toward the crest of the west ridge, beyond the plot later defined as territory 3.

Standing near the center of that area (figs. 1, 2), a wing flutter was heard from among open pines on the slope above me. At once, another unseen bird, less than 100 yards to the northwest, uttered wavering notes of warning. A hidden grouse repeated the alert a similar distance along the slope to the south. Presently, from directly up slope, a drummer performed several times. When I entered an open stand of conifers to investigate the last alarm notes, a male in full display appeared from behind antelope brush and crossed the trail, and a hen hurtled into a pine. After half an hour these two courting birds flew into an isolated lower grove, and I circled back up hill to locate the wing drumming heard there. At that point, another strutting male flushed and flew 30 feet into a pine. He hooted tentatively and displayed. Soon he whirled away through the dense border forest toward the upper ravine. This was believed to have been Male B, and he was probably the second of the two grouse that had preceded me down the draw.

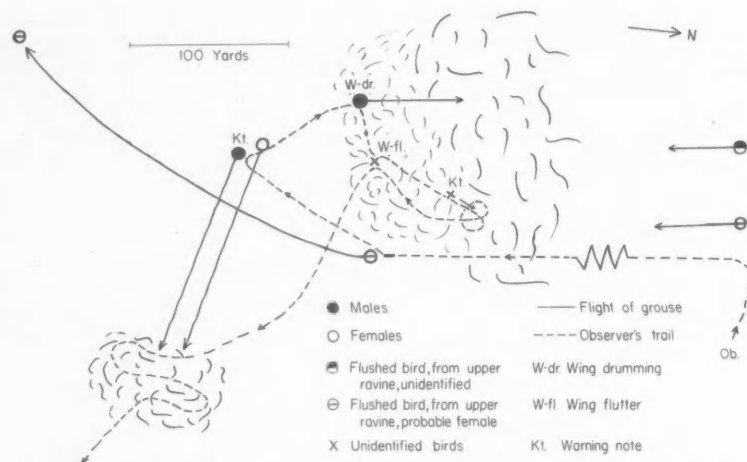


Fig. 2. Communal courtship of Blue Grouse, lower ravine, Purcell Range site, 5:10 to 6:15 p.m., April 22, 1957.

At once a wing flutter from the higher branches of tall, clustered pines down hill echoed his departure. Beyond in the undercover, where alert notes had first been heard, there was the sudden sound of a bird in short flight. Three Blue Grouse, two displaying males and a hen, had been seen on the slope. Another grouse, probably the hen from up ravine, had flown over to the crest of the west ridge. The final wing note from high in the pines, and the sudden burst of flight sound beyond it into denser timber, indicated the presence of two more grouse on the west slope. It seemed apparent that six courting birds had been located or observed within an area of about 125 yards diameter. It was now 6:15 p.m. and the grouse had dispersed.

On May 9, there was again much courtship activity in the lower ravine. A third performer, in addition to Male C and the hen, was briefly heard on the hillside just above territory 3. Male A drummed vigorously in response from the east slope, and he was observed there in full display. Before leaving at 7:15 p.m., I gained the impression that disruption of nuptial activities on the west slope, and my passage back and forth between these birds across the open floor of the draw, had likely inhibited another communal gathering like the one I had witnessed on April 22. Several authors (Schottelius, MS; Jewett, Taylor, Shaw, and Aldrich, 1953:194; Caswell, MS; Hoffmann, 1956:327, 332) have reported or recognized a tendency toward communal display (with no apparent territoriality) in the *obscurus* group of *Dendragapus*. These views are the result of observations of the race *D. o. pallidus* in open country.

The present study indicates that the timber-dwelling population of Dusky Grouse on the Big Bend of the Kootenai River, referable to the race *D. o. richardsonii*, is characterized by courtship habits of individual display, and by occasional, loosely-organized communal assemblage in the breeding season. As I have noted, displaying males of the *obscurus* group are basically territorial and, to a lesser degree, semi-communal, depending on that phase of diurnal, breeding season activity in which they are engaged.

It is not certainly known whether such gatherings, composed of scattered courting "pairs," assemble on common ground or on the territory of one of the male participants.

The widely drawn boundaries of territory 3, as tentatively outlined, include the site of the communal gathering described. This results from the fact that certain vegetational units, such as border forest and adjacent brushy pine slope, together with the movements of the occupant male, indicated that it was a natural inclusion. Further, when the courting group was interrupted, Male C was displaying at his usual station fairly close to the others.

There is reason to believe that the social organization of this group is typical of populations of the Dusky Grouse which live in similar environments in timbered country. It may be suggested that, since displaying male Sooty Grouse commonly descend to the ground at the climax of the breeding season (Haskin, *in* Bent, 1932:105), the possibility of loosely formed, small gatherings of courting pairs at forest edge or like situations should be investigated in the coastal races.

#### CONCLUSIONS

Observations of a population of forest dwelling Blue Grouse in northwestern Montana indicate that the breeding males are markedly territorial, participating to a lesser extent in communal courtship display, and further, that females seek calling males on the latter's territories. These females announce their presence at, or not far within, the territorial borders by wing signals to which the males react, and they are courted there by the occupant males. Open stands of timber, edge situations, or small openings in the timber, on the male's territory, seem favored as courting grounds.

Whether females initially seek males on their individual territories, or on communal courtship grounds, for fertilization is not known. It seems probable that display by the individual males, each on his chosen territory, precedes the gathering for group display. Furthermore, the loosely-organized communal activity seems to arise from such social stimuli as those generated by rival and responsive wing drumming. Early spring movements were not witnessed, and no evidence is available to support this supposition.

The use of one wing signal, namely, the wing flutter, by both sexes suggests that this is the basic form of wing signal in the species, and that its further development in the male gave rise to drumming. I did not actually see this wing note performed by the female, since I paid most of my attention to displaying males. However, investigation disclosed that the hen was at nearby locations when the wing flutter was heard. Finally, when the sound of the wing flutter, as given by both sexes, had become very familiar to me, Male A was observed performing it.

Some slight behavioral evidence of a rather strong pair bond was noted: (1) "pair" flights, (2) vocal danger-warnings to the male by the female, and (3) response of the male to warnings by the female.

Discussing a population of grouse at Sage Hen Creek, California, Hoffmann (1956: 329) states: "The validity of a census of displaying males rests upon the territorial behavior exhibited by adult male Sooty Grouse during the courtship period." Evidence of "strongly developed territoriality" has accumulated with respect to the *fuliginosus* group. No similar basis for a census of breeding males has been available for the study of Dusky Grouse populations. Even the casual location of hooting males of the *obscurus* group in forest environment has been complicated by the low-toned calling of these birds. With the recognition of territoriality, systematized studies become feasible. Such a procedure aids in wildlife management. The study of the breeding habits of the predominantly ground-displaying Dusky Grouse, supplemented by the establishment of territorial location, should inevitably prove more rewarding than field observations of the tree-hooting Sooty Grouse. Recent success in locating one or more of three individuals on each of nine trips to a forest area was largely due to acquiring such information.

## SUMMARY

Three displaying Blue Grouse males were identified on individual territories. None was noted elsewhere between April 16 and June 3, 1957, in 21 hours of close-range observation, except during one evening of group display. Movements and daily routine of breeding males on their home grounds were recorded. Wing notes, hooting, hooting stations, drumming, and courtship are described in relation to territorial occupancy.

The behavioral characteristics of this population reinforce known affinities, and establish new relationships, between the racial groups of *Dendragapus obscurus*.

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*Libby, Montana, December 6, 1957.*

## PELAGIC BIRDS OBSERVED ON A NORTH PACIFIC CROSSING

By WILLIAM J. HAMILTON III

Kuroda (1955) recently demonstrated the inadequacy of our knowledge of the distribution of pelagic birds of the North Pacific Ocean by collecting three species of shearwaters new to the western North Pacific. Other reports of precise distributional data for pelagic North Pacific birds away from the coasts include Arnold's (1948) record of birds seen from a destroyer in the Aleutian area and Yocom's (1947) and Thompson's (1951) reports on the behavior and distribution of Black-footed Albatrosses (*Diomedea nigripes*) between San Francisco and Hawaii.

In June, 1955, I crossed the North Pacific on a troopship along the course shown in figure 1. The ship maintained a nearly constant speed of 16 knots (18.4 mph). Table 1 lists the daily position of the ship at noon, the height of waves, and air and water temperatures. The International Date Line was crossed on June 8. For the sake of clarity, June 8, west of the date line, has been designated June 8 W, and June 8, east of the date line, June 8 E. Four hours of observations were made daily from a lower deck on the north side of the ship. Alexander's book (1928) was used in making identifications. The number of individuals of the commonest species seen and identified is recorded in table 2. All figures represent cumulative daily totals except those for the albatrosses. Figures for the albatrosses indicate the maximum number following the ship at any one time during the observation period. In addition to the species listed in table 2 and in the annotated list, a large number of birds which were not identified to species was seen. Many black storm petrels were about on June 4 and 5 and fewer were seen daily until June 11. At least three species were noted, two dark-rumped forms and one white-rumped form. On June 4, hundreds of large, white-bellied petrels were about. The number of these birds dwindled daily, the last five being noted on June 8 W.

Several factors make it difficult to assess critically the apparent daily fluctuations in the numbers and relative abundance of the species seen and to make comparisons with the observations of others. The most important of these factors is the limited scope of the data, since all observations were confined to a period of 11 days in June. Seasonal movements cannot, therefore, be considered in an evaluation of observed local concentrations. Waves limited the visibility of birds sitting on the water to 300 yards. Birds skimming low over the swells, such as albatrosses, shearwaters, and petrels, are more easily overlooked in rough water. King and Pyle (1957) found an inverse correlation between the height of waves and the number of scattered birds sighted per hour in the Central Pacific. Some birds, especially certain species of shearwater, may become more active under windy conditions (Kuroda, 1955). The ship-following habit of certain storm petrels and albatrosses makes them particularly conspicuous and adds an additional bias to comparisons of species abundance. Daily activity cycles may also affect the data obtained (Yocom, 1947; King and Pyle, 1957).

The ocean currents and water masses encountered may be briefly described as follows: on June 4 and 5, we passed through an area where the cold Subarctic Pacific Water mass, carried south by the Oyashio Current, mixes with the warmer waters of the Central Water mass being moved northeast by the Kuroshio Current. Both are deflected east, the Kuroshio continuing as the Kuroshio Extension and the North Pacific Current and exerting a warming influence on the waters encountered until we approached longitude 170°W (June 6–June 8 E). Here, the cooling influence of the more northern Aleutian Current, which is the eastward deflection of the Oyashio Current, prevailed. This current flows east to the American coast, dividing there and flowing south as the

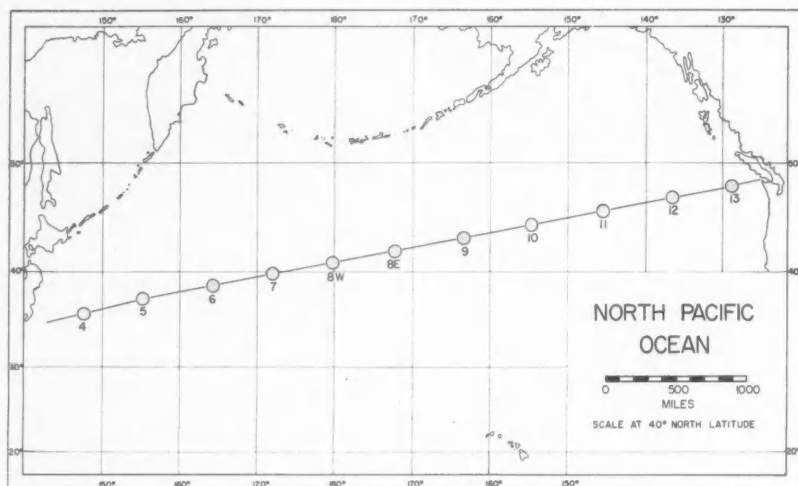


Fig. 1. Noon positions during crossing of North Pacific Ocean in June, 1955.

California Current and north as the Alaska Current (Sverdrup, Johnson, and Fleming, 1942). Thus, with no essential change in the supplying current, water temperature remained nearly constant during the last five days of the trip (June 9-13).

#### ANNOTATED LIST OF SPECIES

*Diomedea nigripes*. Black-footed Albatross. This species now breeds on the Leeward Islands of Hawaii, on the Marshall and Volcano islands, and on Johnston Island. Nonbreeding individuals range throughout the North Pacific and south Bering Sea (Alexander, 1954). There has been considerable interest in determining the factors which may influence the concentrations of nonbreeding individuals. In the course of systematic cruises in the waters off the southern coast of California, Miller (1940) found Black-footed Albatrosses concentrated where upwelling at the continental shelf produced cold and turbulent surface waters rich in nutrients and zooplankton. In the coastal channel he found none; farther west the number quickly dropped to zero as the surface waters became warmer and the upwellings were left behind. Yocom (1947) failed to find a similar concentration at the continental shelf farther north, and he concluded that this species was uniformly distributed in the waters through which he sailed. However, his observations in the coastwise waters were much less extensive than those of Miller. Thompson (1951) found a considerably greater number of albatrosses following his ship in the colder waters of the California Current than in the warmer waters of the East Central Water mass to the west. This relationship held at all seasons. He suggests that concentrations of Black-footed Albatrosses are "confined to low temperature waters, rich in nutrients and of a high biotic productivity." He also devised an index to jellyfish abundance and found that it closely paralleled the abundance of the albatrosses.

Black-footed Albatrosses were seen every day except June 8 W, the date of maximum abundance of the Laysan Albatross. In the warmest waters, which were encountered off the coast of Japan, a number of Black-footed Albatrosses continually followed the ship. The number dwindled at mid-ocean and in the five days preceding the final day of the trip only an occasional small group of stragglers was about. Then, on the final day of the voyage, within 200 miles of Seattle, a great number of Black-footed Albatrosses accompanied the ship to within a few miles of Cape Flattery; the last of these birds turned away less than a mile from land. The recorded water temperatures show that maxi-

Table 1

Noon Positions and Noon Air and Water Temperatures with Variation  
Between 8:00 a.m. and 8:00 p.m.

Date, 1955	Noon position		Air temperature in degrees centigrade	Water temperature in degrees centigrade	Wave height in feet
	Latitude	Longitude			
June 4	35° 35' N	148° 12' E	21 (20-21)	21 (17-21)	3-5
June 5	37° 05' N	156° 08' E	18 (17-19)	17 (17-18)	3-4
June 6	38° 30' N	164° 29' E	14 (12-14)	15 (15-18)	3-6
June 7	39° 40' N	172° 15' E	12 (11-14)	15 (14-15)	5-9
June 8 W	40° 50' N	179° 55' W	13 (12-13)	12 (12-13)	4-7
June 8 E	42° 12' N	172° 05' W	12 (11-12)	11 (11-12)	2-5
June 9	43° 21' N	163° 19' W	11 (7-11)	11 (9-11)	1-2
June 10	44° 28' N	154° 44' W	9 (8-12)	10 (10-10)	0-1
June 11	45° 51' N	145° 35' W	9 (9-12)	9 (9-10)	1-2
June 12	47° 09' N	136° 35' W	9 (9-11)	11 (10-11)	2-3
June 13	48° 09' N	127° 12' W	8 (8-16)	11 (10-11)	2-8

Table 2

Number of Individuals Seen During Four-hour Observation Period

Species	Date in June, 1955											
	4	5	6	7	8W	8E	9	10	11	12	13	
<i>Diomedea nigripes</i>	25	14	8	15	0	3	9	3	3	3	30	
<i>Diomedea immutabilis</i>	0	0	1	5	10	8	0	0	0	0	0	
<i>Puffinus</i> sp.	100+	300+	54	75	2	8	11	163	68	135	10	
<i>Pterodroma inexpectata</i>	0	0	0	0	4	6	8	5	0	0	0	
<i>Oceanodroma furcata</i>	0	0	0	0	0	0	0	0	0	12	2	
<i>Phalaropus fulicarius</i>	0	0	0	13	0	0	0	6	22?	0	0	
<i>Fratercula corniculata</i>	0	0	0	0	0	4	2	1	2	4	0	
<i>Lunda cirrhata</i>	0	0	0	0	0	4	33	73	4	11	8	
Black storm petrels	abd. <sup>1</sup>	abd.	many	many	many	19	9	4	0	0	0	
Unidentified large petrels	abd.	many	55	34	5	0	0	0	0	0	0	

<sup>1</sup> Abd. = abundant.

Table 3

Black-footed Albatross Abundance and Sea Water Temperature in the Northwest Pacific,  
compiled from Kuroda (1955)

Temperature, degrees C.	2-3	4-5	6-7	8-9	10-11	12-13	14-16
Number of days	3	15.5	12.5	3	1	2	1
Albatrosses per day	0.0	0.2	0.2	1.6	10	8.5	11

num numbers occurred in both the coldest and the warmest waters encountered. The cold water conditions off Seattle were not of a local nature but extended throughout a considerable part of the North Pacific which we traversed; the abundance of albatrosses, on the other hand, was much more local. Further, the abundance of this species in the warm (14°-17°C.) waters off Japan suggests that concentrations are not actually confined to waters of low temperature. Kuroda (1955) also found the greatest numbers of this species in the warmest waters he encountered (table 3) although the temperature ranges which he recorded barely overlap those of Thompson (1951).

Considering all available data, however, it seems likely that we are dealing, not with a direct influence of water temperature, but rather with the combined influence of all of the factors which determine the food supply of this species. These factors probably vary in different parts of the non-

breeding range, and they may or may not be strictly dependent on water temperature. One such factor may be the habit of scavenging after ships. The concentrations of albatrosses in the heavily fished waters off the coast of central Japan, near the coast of northern Japan (Kuroda, 1955), and again off Seattle suggest such an explanation. Yocom (1947) found that a number of albatrosses concentrated about his ship within a day after anchoring; apparently the birds were attracted by garbage thrown overboard. It seems unlikely, however, that the observations of Miller (1940) and Thompson (1951) can be accounted for in such a manner. Extensive observations and a further analysis of the food supply of this species will probably be necessary before the factors influencing its pelagic distribution can be determined with any degree of certainty.

On days when this species was most frequently encountered, the number usually mounted throughout the day until late afternoon, when it would decrease again before dark. There was also a tendency for the number of albatrosses to peak slightly in the early morning. It seems unlikely that the late afternoon peak is the result of a gathering of birds behind the ship during the day, since carefully observed individuals usually followed the ship for less than three hours (about 50 miles). Miller (1942) found that of 25 individuals of this species marked off southern California only one persisted for as far as 50 miles.

*Diomedea immutabilis*. Laysan Albatross. This species seems less prone to follow ships than is the Black-footed Albatross (Thompson, 1951; personal observation). However, as many as 10 trailed the ship on one occasion. Usually individuals passed our ship without turning, and for this reason the figures recorded for this species in table 2 probably represent a greater density than similar figures for the Black-footed Albatross. On June 8 W and June 8 E, when the greatest number of this species was seen, the birds seemed to be quite evenly distributed throughout the area. No more than one individual was in sight at any one time other than the small group which followed the ship. One individual overtaken on the water took flight by spreading its wings and running over the surface into the wind. The wings were slightly elevated and held fixed. When it was airborne, a slight change in the pitch of the wings sent it gliding down the trough of a wave and away without ever having flapped its wings.

*Puffinus tenuirostris* and *P. griseus*. Slender-billed Shearwater and Sooty Shearwater. These two species are treated together because of the difficulty encountered in making positive identifications. The whiter under wing coverts of *griseus* and the somewhat less rigid wing stroke of *tenuirostris* (Nichols, 1946) seem to be the best characters to separate them in flight. The larger size of *griseus* is perhaps a deceptive character unless direct comparison is possible. Concentrations off the Japanese coast were probably mainly of *tenuirostris*. At 4:00 p.m. on June 5, we passed more than 100 shearwaters in a group on the water. On the same date, considerable numbers were seen flying slightly west of north into a wind of 10 knots out of the northeast. After June 8 E, *griseus* seemed to be commoner than *tenuirostris*. Often this species was seen with whales. A single bird just off Cape Flattery was most probably *griseus*.

*Pterodroma inexpectata*. Scaled Petrel. Of the 23 birds identified, ten were flying in pairs; the rest were seen singly. On June 8 E, a pair was seen in the company of a Laysan Albatross about a whale.

*Oceanodroma furcata*. Fork-tailed Petrel. Scattered single birds were seen well off the Washington coast; they were 100 miles or more from land.

*Phalaropus fulicarius*. Red Phalarope. On June 7 two pairs rose from the water and zig-zagged out of sight in front of the ship. The sexes were undetermined. The individuals of each pair flew less than three feet apart while the pairs themselves were over 100 feet apart. The other birds seen on June 7 were a single individual and a flock of eight. On June 10, three pairs were sighted flying low over the ocean. They settled on the water, and when they took flight again, as the ship approached, all of the individuals were well separated. Two more flocks of 10 and 12 phalaropes, seen on June 11, could have been of either this species or the Northern Phalarope (*Lobipes lobatus*).

*Catharacta skua*. Skua. A single bird was noted on June 8 E.

*Larus glaucescens*. Glaucous-winged Gull. Two joined the Black-footed Albatrosses which were following the ship 30 miles west of Cape Flattery.

*Sterna* sp. A single light colored tern passed the ship in the early morning of June 8 E and continued on out of sight to the north.

*Uria* sp. We came on two murrets sitting on the water shortly before noon on June 9 when we



were over 750 miles from the nearest island of the Aleutians. They dove quickly and were not seen again.

*Cerorhinca monocerata*. Rhinoceros Auklet. Two flew past the ship 18 miles off Cape Flattery.

*Fratercula corniculata*. Horned Puffin. Scattered individuals of this species were noted over a wide area across the ocean. They were easily distinguished from the following species by their white underparts and whitish cheeks. One seen on June 11 was in fully adult plumage while all the others were in more worn plumage. Throughout the voyage none was seen flying. This species has apparently never been recorded from the open waters of the North Pacific before.

*Lunda cirrhata*. Tufted Puffin. Almost all of the individuals noted were single birds in dull plumage. Occasionally two were noted within a few yards of one another, but no greater concentration than this was seen. One flying bird was seen on June 11 and several more were aloft on June 12. On June 13, all of the eight birds seen were flying in pairs and these birds were much more brilliantly colored than any seen at mid-ocean. Probably these were breeding birds from the nearby coast. The remainder of the birds recorded in table 2 were overtaken as they sat on the ocean where they were visible up to about 250 yards. Thus it seems likely that a large number of this species was scattered on the open waters of the North Pacific south of the Aleutians at the time of this voyage. Bent (1919:88) reports that "after the breeding season is over and the young are able to take care of themselves they all move away from their summer homes, to roam about on the open seas, where very little seems to be known about their winter habits. I have seen this species farther from land, by several hundred miles, than any of the other Alcidae and suppose that they are widely scattered during the winter over the north Pacific Ocean." Perhaps the birds seen at the time of this voyage were immature birds of the previous year which had wintered on the open ocean. In this species, as in other Alcidae, the molt seems to include a complete and simultaneous shedding of the primaries, leaving the bird temporarily flightless. Many of the individuals overtaken on the water seemed to lack wing quills and flapped helplessly away from the oncoming ship in a manner reminiscent of a flightless duck. Other birds with fully grown wings rose from the water only after extended runs across the surface and seemed to have particular difficulty on calm water or when fresh winds were lacking. Kuroda (1955) collected several flightless birds in June in the western North Pacific.

#### SUMMARY

Observations on birds seen during 11 days of a North Pacific crossing from the waters off central Japan to Seattle are recorded. The correlation of water temperature with the occurrence of nonbreeding concentrations of Black-footed Albatrosses is discussed, and it is suggested that further records are necessary to adequately evaluate the factors influencing the distribution pattern. Three species of alcids, the Tufted Puffin, Horned Puffin, and a species of murre were seen on the open ocean several hundred miles from the nearest land.

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PTERYLOGRAPHY AND NATURAL AND EXPERIMENTALLY INDUCED  
MOLT IN CLARK'S NUTCRACKER

By L. RICHARD MEWALDT

One of the more demanding processes in the lives of birds in the higher latitudes is the annual molt. When data on the molt from 439 Clark's Nutcrackers (*Nucifraga columbiana*) became available, it was apparent that its timing and duration were somewhat unusual. Early in the study of the nesting cycle (Mewaldt, 1956), it was noted that some birds were in molt at the height of the nesting season. Although some species of birds in equatorial regions are known to be in molt while nesting (Moreau, Wilk, and Rowan, 1947; Miller, 1955), birds in the high latitudes generally do not molt until the nesting season is over.

To reinforce the data from the collected birds, records on the sequence of molt were obtained from 65 nutcrackers kept in captivity for varying lengths of time. These captive birds yielded information which is difficult to obtain from preserved specimens.

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## MATERIAL AND METHODS

From October, 1946, to October, 1951, 439 Clark's Nutcrackers were collected. Of these, 428 were collected in western Montana, seven in eastern Washington, two in northern Idaho, and two in Oregon. Although most collections were made in the winter and spring months, some specimens were taken in every month of the year.

The fresh skins were removed and treated on the inside with sodium chloride. Skins of the first 200 (Nc 1 to Nc 200) were washed in detergent and prepared as conventional study skins. The remaining skins were washed in detergent, slit open, and dried flat to facilitate examination of the feather tracts on the inside of the skin. A few specimens were preserved in 70 per cent alcohol for study of their pterylography.

From December, 1948, through December, 1951, from two to 45 nutcrackers were maintained in captivity at Pullman, Washington. In all, 51 were trapped in northwestern Idaho and 14 in the Cascade Mountains of southern Oregon. Individual records of weight and molt were kept until the last six were sacrificed in December, 1951.

Except as noted, the nutcrackers were maintained in cages 12 feet long, 8 feet wide, and 6 feet high. The top and sides were covered with half-inch hardware cloth. At one upper corner, three 4×4 foot panels converged to form a shelter, under which were placed perches and a feed shelf. A 4×4 foot compartment, 6 feet high, in the opposite corner from the shelter served as a safety entrance and a catching chamber. Perches were placed in several positions about each cage. No more than 12 nutcrackers were placed in each cage. Two birds which escaped, after having been held captive for more

than a year, proved that they were still strong fliers by making their escape by sustained flight away from the aviary. Cages for experimental birds were located on the roof (sixth level) of Science Hall. These cages were protected from direct wind blast and city lights by a screen made of one-fourth inch corrugated cement asbestos board seven feet high. Control birds were kept in cages of the same construction at ground level about 400 yards from Science Hall.

The basic diet, kept constantly available, consisted of Larro Egg Mash Pellets, a commercial poultry feed containing about 20 per cent protein. A weekly supplement of about 15 grams of fresh pork liver per bird was provided. Especially in the winter months, the carcasses of mice and other mammals were quickly eaten when available. Fresh water was provided daily except that snow, when present, was taken by the nutcrackers in preference to water. Raw piñon seeds (from *Pinus edulis*) obtained from New Mexico were eagerly taken whenever placed in the cages.

#### PTERYLOGRAPHY

What few references I have been able to find pertaining to pterylography in the genus *Nucifraga* have been fragmentary. A résumé of the feather tracts of Clark's Nutcracker follows. It was obtained, in the main, from 12 specimens preserved in alcohol. The terminology used is adapted from Boulton (1927), Pitelka (1945), and Mayaud (1950). Figures 1 and 2 are designed to assist in following this résumé.

*Alar tract.*—Clark's Nutcracker has 20 remiges. All ten primaries, the proximal designated as number 1, are well developed. The shortest is number 10 and the longest either number 5 or 6. The small tenth (proximal) secondary is usually distinguishable from nearby coverts by its slightly duller coloration and by its extension somewhat posterior and proximal to overlying coverts. Although there are ten greater primary coverts, only nine middle primary coverts were found, the first (proximal) being absent. No lesser primary coverts could be distinguished. The carpal remex (Mayaud, 1950) was found at the base of the first primary, approximately where the first primary covert would be expected. It is intermediate in size between the second middle primary covert and the first middle secondary covert. The carpal covert is inserted between the bases of the first primary and the first secondary. Ten greater secondary coverts are inserted at the base of and slightly proximal to each corresponding secondary. Nine middle secondary coverts have their insertions alternating with the greater secondary coverts. No lesser secondary coverts were distinguished. Another covert-like feather described by Pitelka (1945:232) for a race of the Scrub Jay (*Aphelocoma coerulescens insularis*) as a small covert lying "posterior and medial to the innermost of the three feathers of the alula . . .," seems in the nutcracker to be definitely associated with the alula. The alula supports three principal feathers, the one covert just mentioned, which is probably a degenerate fourth alular feather, and a number of small coverts which are continuous with the numerous marginal coverts. The marginal coverts extend from the leading edge of the wing toward the bases of the primary and secondary coverts. The carpometacarpal coverts extend distally from the alula to the base of the tenth primary along the leading edge of the manus.

There are ten lower greater primary coverts and ten lower lesser primary coverts. The homology of the first lower lesser primary covert is in doubt. It may be the displaced first lower lesser secondary covert (Pitelka, 1945), or the lower carpal remex covert (Boulton, 1927). In Clark's Nutcracker, just proximal to the first lower lesser primary covert is seen a substantial down-like feather. There are no lower middle primary coverts. A careful search reveals what may be six or seven much reduced lower greater secondary coverts proximal to each of the six or seven secondaries. There are what appear to be nine lower middle secondary coverts, the first inserted between the first primary and the first secondary, below the first lower lesser primary covert. There are apparently ten lower lesser secondary coverts. However, either of the last two mentioned coverts may actually be a part of the series of lower middle secondary coverts, forming the tenth feather of that series. The long and fine lower marginal coverts only sparsely cover the lower wing area proximal to the metacarpal region. The ten or 12 tertiaries extend in a single row along the trailing edge of the wing posterior to the humerus and, along with scattered down feathers, complete the wing cover.

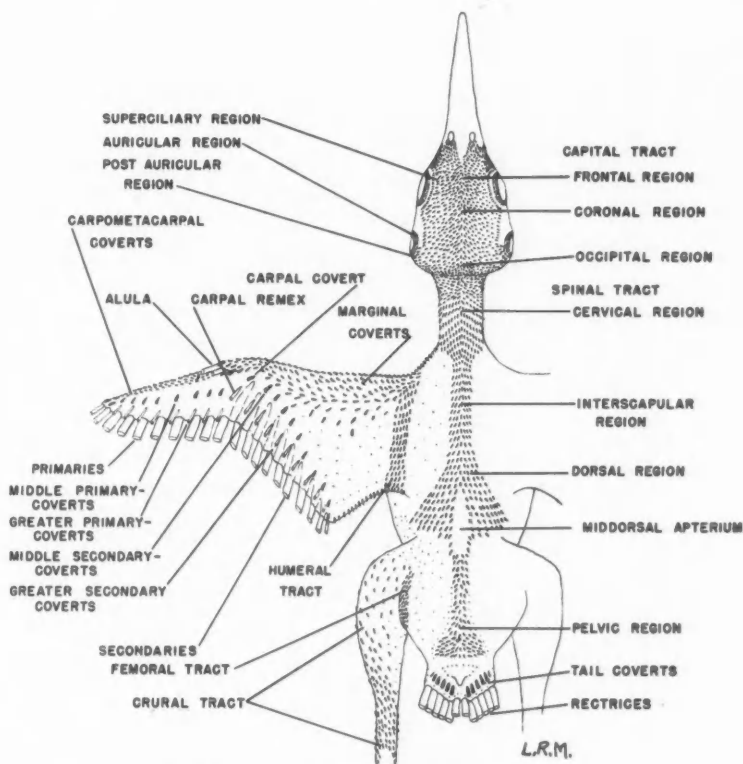


Fig. 1. Pterylography of Clark's Nutcracker, dorsal view.

*Caudal tract.*—There are 12 fully developed rectrices. The center pair (1-1) have been displaced dorsally. There are either ten or 12 upper tail coverts. The outermost pair (6-6) is always small if present. This outermost pair was present on nine out of 12 specimens of nutcrackers preserved in alcohol, although it was very much reduced on three of these nine. Twelve down feathers form an incomplete ring anterior to the uropygial gland. There are two principal rows of lower tail coverts of ten each, plus another 14 or 15 smaller feathers on each side enclosing an apterium between the anterior row of under tail coverts and the anal circlet. The anal circlet appears to be composed of four or five rings of feathers almost completely encircling the cloacal aperture.

*Capital tract.*—The dorsal and lateral surfaces of the head are densely feathered except for two pairs of lateral apteria. The down-filled temporal apterium extends from the corner of the mouth (gape), between the eye and ear, to a point just dorsal to the posterior margin of the ear. The post-auricular apterium is essentially continuous with the lateral neck apterium. The eye is surrounded by two complete circles, and the ear is surrounded by three complete circles of small feathers.

*Spinal tract.*—The spinal tract is alternately six and seven feathers broad (see fig. 1) in the interscapular region and two or three times as broad in the dorsal and cervical regions. An elongated middorsal apterium, which parallels the long axis of the body, may be found in the posterior portion of the dorsal region of the spinal tract of fresh and spirit specimens. The spinal tract becomes wider in the cervical region and at its terminus in the pelvic region.

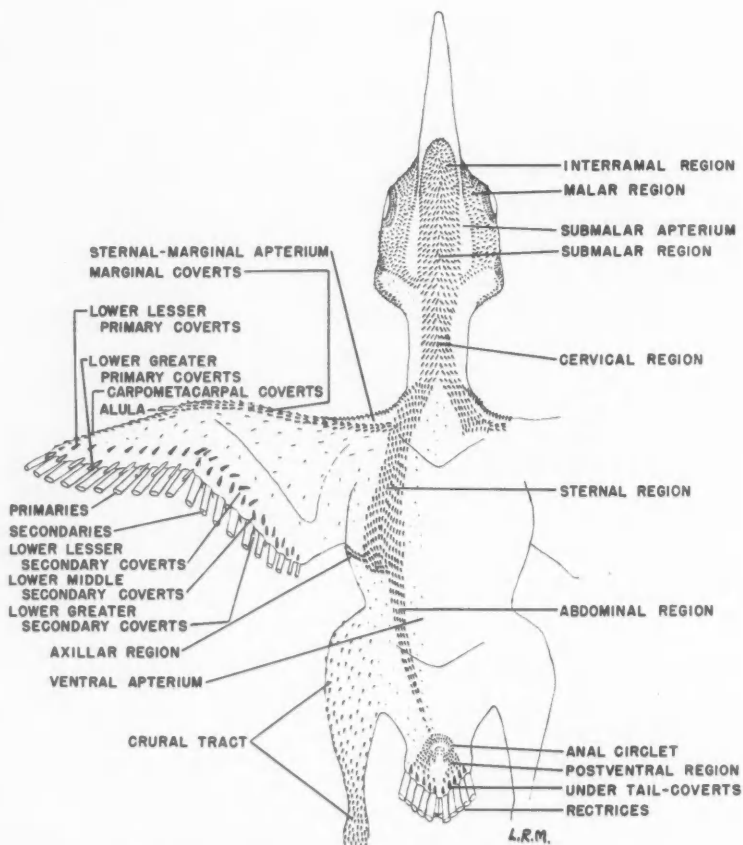


Fig. 2. Pterylography of Clark's Nutcracker, ventral view.

*Humeral tract.*—From the junction of the leading edge of the wing with the body, the humeral tract extends over the dorsal surface of the base of the wing to the medial tertiaries of the alar tract.

*Femoral tract.*—Four to five feathers broad, the femoral tract crosses the dorsal surface of the thigh, with the proximal portion directed toward the caudal tract.

*Crural tract.*—The feather covering of the hock varies from sparse on the proximal portions, to relatively dense just above its junction with the shank.

*Ventral tract.*—The submalar apteria which separate the interramal region from the malar regions are distinct but contain considerable down. There is an acute triangular apterium butting on the ventral tract and extending between the dorsal and ventral marginal coverts along the leading edge of the wing. The axillar region extends from the base of the sternal region of the ventral tract to the ventral border of the axilla.

*Apteria.*—The apteria contain some down feathers which tend to obscure some of the feather-free areas on certain parts of the bird. The abdominal apterium of breeding birds becomes free of down feathers when the incubation patch is formed in females and males (Mewaldt, 1952) during active nesting seasons.

## DISCUSSION OF PTERYLOGRAPHY

In most instances, differences in feather distributional pattern were not detected upon comparison with the accounts published by investigators concerned with pterylography in Corvidae. However, two variations were evident and seem of sufficient importance for discussion. Comparisons were made among specimens of 13 genera, as follows: five *Aphelocoma coerulescens coerulescens*, one *Aphelocoma coerulescens californica*, one *Calocitta formosa*, one *Cissilopha beecheyi*, two *Corvus brachyrhynchos*, one *Corvus corax*, one *Gymnorhinus cyanocephala*, four *Cyanocitta stelleri*, one *Cyanocorax chrysops*, one *Cyanocorax yncas*, one *Garrulus* sp.?, one *Kitta chinensis chinensis*, 12 *Nucifraga columbiana*, two *Perisoreus canadensis*, five *Pica pica hudsonia*, and one *Psilorhinus morio*.

*The middorsal apterium.*—Pitelka (1945) reported the absence of the fissure-like space, here designated as the middorsal apterium, in the dorsal region of the spinal tract in *Aphelocoma* and *Cyanocitta*, while confirming its presence in *Corvus*. In the material available to me, I have found the middorsal apterium discernible in representatives of all genera except *Aphelocoma*, *Cissilopha*, *Cyanocitta*, *Perisoreus*, and in *Cyanocorax yncas*. *Cyanocorax chrysops*, presumed to be closely related to the genus *Aphelocoma* (Pitelka, 1945), was found to have the middorsal apterium present in agreement with Nitzsch (*vide* Sclater, 1867). However, *Kitta chinensis*, included by Nitzsch in the Paradisaeidae and figured without the middorsal apterium, was found to have this apterium distinctly present on the one specimen (USNM 19579) examined. It is perhaps significant to note that Stonor (1942) reported the absence of the apterium in *Callaeas cinerea*, the Blue-wattled Crow of New Zealand, which is not generally included in the Corvidae.

How important the presence or absence of the middorsal apterium may be in a phylogenetic consideration is questionable. It is worth noting that the representatives of *Aphelocoma*, *Cissilopha*, and *Cyanocitta* examined, all included as subgenera in the genus *Cyanocitta* by Amadon (1944), were found to be without a middorsal apterium. However, a middorsal apterium was present in the representatives of three genera examined (*Psilorhinus*, *Calocitta*, and *Cyanocorax chrysops*) which were shown by Amadon (1944:17), in a proposed phylogenetic tree, to have arisen from a *Cyanocitta*-like ancestor. Also *Perisoreus* (*Cractes* of Amadon), which lacks the apterium, was believed to have arisen from a stock in common with *Garrulus*, a representative of which was found to possess the middorsal apterium.

*The upper tail coverts.*—Boulton (1927) and Pitelka (1945) showed only five pairs of upper tail coverts and they presumed the most recently degenerate pair to be 1-1, represented by two down feathers near the bases of rectrices 1-1. Some species of the Corvidae which were examined had distinct, although reduced, upper tail coverts 6-6. Not all specimens of these species were found to have coverts 6-6, for example, *Nucifraga columbiana*. Some genera, including *Aphelocoma*, showed no trace of coverts 6-6. However, the presence of coverts 6-6 in some specimens, and a down feather remnant in others, suggests that, at least in the Corvidae, upper tail coverts 6-6 may be the most recently degenerating coverts, rather than coverts 1-1.

## MOLT

The plumages of Clark's Nutcracker may be summarized as follows: (1) the juvenal plumage, acquired by the postnatal molt, is the first covering of feathers and is the plumage designation until the completion of the postjuvenal molt; (2) the first-year plumage, acquired by the postjuvenal molt, is the plumage designation until, during their first postnuptial molt, first-year birds are no longer distinguishable from adults;

(3) the adult plumage, acquired by the first postnuptial molt, is renewed each year by subsequent postnuptial molts.

Molt as here used is the orderly dropping of feathers and their replacement in a sequence characteristic of the species concerned. It does not include the accidental dropping of feathers and their subsequent replacement. The period of a molt extends from the time that the first feathers are dropped until the last feathers dropped in that molt are fully replaced and hardened.

Nutcrackers in the postnatal molt are the youngest birds considered. They are classified as juveniles (in juvenal plumage) until the partial postjuvinal molt is completed. First-year birds (in first-year plumage) can be identified as such by the incompleteness of the postjuvinal molt. Birds in first-year plumage can usually be distinguished until about July of their second year (when they are 13 to 16 months of age) when their first postnuptial molt is so advanced that they are indistinguishable from adults on the basis of plumage characters. Males and females within each age group are treated together, for no significant differences in the time or in the sequence of molt were detected. A discussion of plumage as it is related to age and sex may be found in the section on age and sex heteromorphism.

*Postnatal molt.*—It is by means of the postnatal molt that the young bird acquires its first feather covering. Although the young nutcracker is fairly well covered with feathers when it leaves the nest at about 20 days of age (Mewaldt, 1956), feather growth continues for at least two or three weeks.

Birds at the time they leave the nest have gray eyes, gray feet, and the inside surfaces of their bill and mouth vary from pale salmon-red to white. Feathers are growing in every tract except the capital tract. Usually primaries 1 to 9 are soft and still growing, whereas primary 10 and the ten secondaries are fully grown and are hard. The upper wing coverts are usually hard, with the exception of the marginal coverts, many of which are incompletely grown. The lower wing coverts are more than half grown. Pitelka (1945) found young *Aphelocoma coerulescens* lacking lower wing coverts as late as the time of departure from the nest. Feathers in the central portions of most feather tracts on the body are fully grown, but those along the edges of the spinal and ventral tracts, and the posterior portions of the humeral and femoral tracts, are soft and only partially grown.

The last traces of the postnatal molt appear in the lateral portions of the dorsal region of the spinal tract; however, feathers apparently do not completely fill the lateral angles to their apices until near the end of the postjuvinal molt.

During the postnatal molt, the eyes change gradually in color from gray to brown and the feet from gray to black. Black areas appear in the white inside surfaces of the bill and mouth and gradually increase in size until well into the postjuvinal molt when the inside of the bill and mouth of most specimens is black.

*Postjuvinal molt.*—Evidence from the few specimens collected in sufficiently early stages of the postjuvinal molt suggests a sequence of body molt similar to the body molt in the postnuptial molt of first-year and adult birds. The partial postjuvinal molt involves all body feathers, but in the alar and caudal tracts it is restricted to certain of the smaller feathers.

The primaries and their coverts, the carpometacarpal coverts, the alula and its coverts, the carpal remex and its covert, and the secondaries are not molted. The greater secondary coverts are not molted with the occasional exception of numbers 8 and 9. Middle secondary coverts 6, 7, and 8 are usually (but not always) molted, and occasionally numbers 4, 5, and 9 are molted in addition. Pitelka (1945) found in *Aphelocoma coerulescens* that most greater secondary coverts and all middle secondary coverts were



MONTH	POSTNATAL MOLT	POSTNATAL MOLT COMPLETE AND POST- JUVENAL MOLT NOT STARTED	POSTJUVENAL MOLT	POSTJUVENAL MOLT COMPLETE
APRIL	.			
MAY	. . . . . . . . . . .	. . . . .		
JUNE	.			
JULY	. . .	.	. . .	
AUGUST		. .	. .	
SEPTEMBER				
OCTOBER			. . .	. .
NOVEMBER			. . . . . . . . . . .	
DECEMBER			. . . .	. . .
JANUARY			. .	. . . . . . . . . . .
FEBRUARY				. . . . . . . . . . .

Fig. 3. Occurrence of molt by months in juvenal and first-year Clark's Nutcrackers.

replaced. He also determined in two races of *Aphelocoma coerulescens* that secondaries 7 to 10 were all, or in part, replaced in 12 of 41 first-year specimens. Mayaud (1948) found in *Garrulus glandarius* that the three proximal secondaries and six proximal greater secondary coverts are replaced as well as all of the middle secondary coverts. Usually all of the marginal feathers on the dorsal surface of the wing of *Nucifraga columbiana* are renewed.

The rectrices are not replaced in the postjuvinal molt. The upper tail coverts are usually molted, but occasionally the middle pair remains until the first postnuptial molt. At least some of the lower tail coverts are replaced.

The postjuvénal molt of the *Nucifraga columbiana* collected in western Montana differs only in detail from that reported for *Aphelocoma coerulescens* (Pitelka, 1945) and from that reported for *Corvus brachyrhynchos* (Emlen, 1936), *Corvus frugilegus frugilegus* (Witherby, 1913), *Cyanocitta cristata* (Arnold, MS), and several other corvids (Dwight, 1900).

In *Aphelocoma coerulescens*, Pitelka (1945) found that the last juvenal feathers to be dropped in the postjuvinal molt are those of the lateral neck region. In *Nucifraga columbiana*, however, it appears that the last trace of postjuvinal molt occurs in the lateral angles of the dorsal region of the spinal tract.

Figure 3 summarizes the condition of molt of juvenal and first-year nutcrackers collected during their first twelve months. It is perhaps significant to note that four juveniles in postnatal molt were collected in the second half of July. Actually two of these four had left their nests only three or four days earlier, for their rectrices and most of their primaries were incompletely grown.

**Postnuptial molt.**—Adult and first-year Clark's Nutcrackers undergo one complete molt, the postnuptial molt, each year starting usually in March or April. This one complete molt is characteristic of adult Corvidae (Sclater, 1867; Dwight, 1900). Pitelka (1945:246) found in *Aphelocoma coerulescens* that this "first complete molt of birds one year of age is initiated, sometimes, before that of older individuals of a given population and usually within the first half of the molt period of the population." That a similar situation occurs in Clark's Nutcracker may be seen in table 1. All first-year birds collected after March 9 were in molt, whereas some adults had not begun to molt when collected in April and May. The first adult molt was found on a specimen collected on March 17.

Table 1  
Occurrence by Months of Postnuptial Molt in Adult and First-year Clark's Nutcrackers  
Collected from February 1 to June 30

Month	Number	Adults		Number	First-year birds	
		No molt	Per cent with Molt		No molt	Per cent with Molt
Feb.	31	100	.....	15	100	.....
Mar.	25	92	8	36	42	58
April	44	27	73	53	.....	100
May	24	12	88	11	.....	100
June	8	.....	100	3	.....	100

Beginning in July, first-year nutcrackers in their first postnuptial molt could not be distinguished from adults in postnuptial molt. The sequence of molt appears to be the same in both first-year birds and adults, even though first-year birds commence molting sooner than adults.

The sequence of loss of the principal feathers of the caudal and especially of the alar tracts in the postnuptial molt is relatively constant. This is true not only within a species but probably throughout the order Passeriformes (Dwight, 1900; Jones, 1930; and Mayaud, 1950). Variations which occur are largely due to differences in overall molting time rather than to differences in order within each feather tract.

The postnuptial molt in Clark's Nutcracker begins with the dropping of primary 1. The molt on the two wings is usually well synchronized. The remainder of the primaries are dropped in order, one at a time, before the next proximal primary is fully grown. Shortly after new primary 5 has begun to grow, secondary 8 is dropped. Within a few days secondaries 9, 2, and 7, usually in that order, are dropped and replaced. Secondaries 3 and 10 are replaced while new primary 8 is growing. Growth of new secondary 4 usually overlaps growth of new primary 9. The three principal feathers of the alula and secondary 5 are usually replaced while new primary 10 is growing. The last remex to be dropped and to be renewed is secondary 6. The rectrices are dropped one pair at a time from the center pair outward, beginning with 1-1 while primaries 4 and 5 are grow-

ing; followed by 2-2 during the growth of primary 6; 3-3 during the growth of primary 7; 4-4 during the growth of primary 8; 5-5 during the growth of primary 9; and 6-6 during the growth of primary 10.

This sequence follows closely that reported for *Aphelocoma coerulescens* (Pitelka, 1945) except that secondary molt begins slightly earlier (with primary 4) and the feathers of the alula are dropped considerably sooner (with primary 6 or 7) in *Aphelocoma coerulescens*. Differences in the time relationships between feather tracts are not apparent when comparison is made between molt in Clark's Nutcracker and molt in the Rook, *Corvus frugilegus frugilegus* (Witherby, 1913). Witherby found that the Rook's secondaries begin to molt when half (five) of the primaries have molted, and that when the tenth primary is growing, the alula is in molt. It should be noted that secondary 7 in *Nucifraga columbiana* is molted earlier than in either *Corvus frugilegus frugilegus* (Witherby, *op. cit.*) or *Garrulus glandarius* (Mayaud, 1948). Except that the Canary (*Serinus canarius*) has but nine primaries and nine secondaries, the order of molt of the flight feathers of an adult male, reported by Vaugien (1948), agrees more exactly with the order in *Nucifraga columbiana* than do the published accounts for other species of Corvidae.

The duration of the postnuptial molt is extremely variable, lasting from a few weeks in some passerine birds to several months in some species in the order Falconiformes (Mayaud, 1950). Most passerine birds complete their postnuptial molt within two months after its inception. Presumably because some species nest late in the summer (July and August) in the north temperate zone, they are found in molt into November (Dwight, 1900).

As more precise information is accumulated regarding the molt in the Corvidae, we find that, as a group, the duration of their postnuptial molt is apparently considerably longer than for most other passeriform birds. Witherby (1913) found that the primary molt of *Corvus frugilegus frugilegus* extended over four or five months, from early May to September in Great Britain. Whereas the postnuptial molt occupies about three months in certain races of the genus *Aphelocoma*, this complete molt in at least one race, *Aphelocoma ultramarina arizonae*, lasts from more than four months to almost six months (Pitelka, 1945). Arnold (MS) found specimens of *Cyanocitta cristata bromia* from New York in molt from June into October, or for from four to five months. Mayaud (1948) found specimens of *Garrulus glandarius* from western France in molt from the beginning of July until the end of September.

The postnuptial molt of Clark's Nutcrackers collected in western Montana extends over a substantially longer period than do the molts of at least some other species of Corvidae. All first-year and adult nutcrackers collected between May 15 and September 18, a four month period, were in the postnuptial molt. Of 243 collected between March 31 and December 1, 93 per cent were in molt. This suggests that the duration of the postnuptial molt for most individual nutcrackers lasts eight or nine months. Although the molt for about the last two months of the period is largely restricted to the lateral portions of the spinal tract, its high frequency of occurrence and constancy of location are deemed sufficient to justify its inclusion within the postnuptial molt. In the populations sampled, some trace of postnuptial molt was detected in every month except February. Miller (1928) noted growing feathers on the throat of *Lanius ludovicianus* for one or two months after what he considered the termination of the regular postnuptial molt.

All first-year and adult nutcrackers collected between May 15 and September 5, a three and one-half month period, were molting flight feathers. Between March 31 and September 1, 91 per cent of 174 nutcrackers collected showed molt of flight feathers,

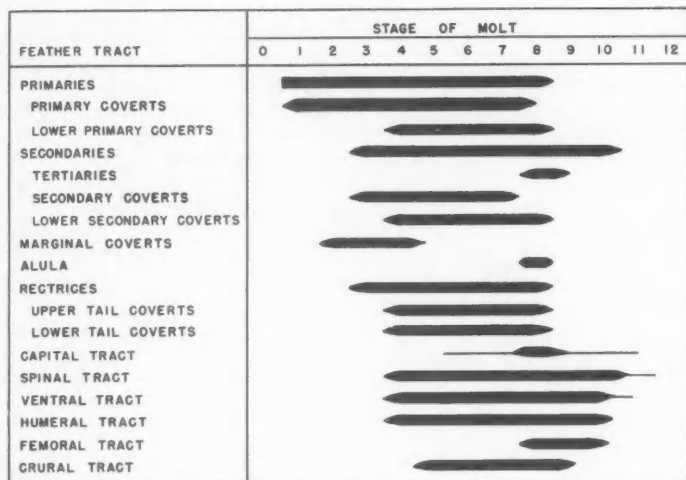


Fig. 4. Sequence of molt by selected groups of feathers as related to thirteen arbitrary stages in the postnuptial molt of Clark's Nutcracker.

indicating that individual nutcrackers take four and one-half or five months to completely replace their remiges and rectrices.

Individual case histories show that 35 captive nutcrackers on normal photoperiods took from six to more than eight months to complete molt of the flight feathers. It is highly probable that the molt of the flight feathers of these captive birds was extended into October and November as a result of their captivity. Similar prolongation of molt was noted by Pitelka (1945) for captive *Aphelocoma coerulescens*.

A series of arbitrary molt stages similar to those used by Pitelka (*op. cit.*) for *Aphelocoma coerulescens* has been outlined so that the progress of the postnuptial molt may be considered with respect to time. Figure 4 displays graphically the portions of the plumage that are in molt simultaneously. There is individual variation, but on the whole the pattern appears relatively constant. Molt of captive control nutcrackers followed the same pattern.

The skin of each adult and first-year nutcracker was assigned to one of 13 groups according to its condition of molt as follows:

- Stage 0 Postnuptial molt not yet begun.
- Stage 1 Primaries 1 and/or 2 missing or growing, 3 to 10 old.
- Stage 2 Primaries 1 and 2 grown, 3 growing, and 4 to 10 old.
- Stage 3 Primaries 1 to 3 grown, 4 and 5 growing, and 6 to 10 old.
- Stage 4 Primaries 1 to 4 grown, 5 and 6 growing, and 7 to 10 old.
- Stage 5 Primaries 1 to 6 grown, 7 growing, and 8 to 10 old.
- Stage 6 Primaries 1 to 7 grown, 8 growing, and 9 to 10 old.
- Stage 7 Primaries 1 to 8 grown, 9 growing, and 10 old.
- Stage 8 Primaries 1 to 9 grown, and 10 growing; secondaries 1 to 3 and 7 to 10 grown, 4 and 5 growing, and 6 old.
- Stage 9 Primaries 1 to 10 grown; secondaries 1 to 4 and 7 to 10 grown, 5 growing, and 6 old.
- Stage 10 Secondaries 1 to 5 and 7 to 10 grown, and 6 growing.



Fig. 5. Progress of postnuptial molt in Clark's Nutcracker as shown by mean stage reached in the month of collection.

Stage 11 Secondaries 1 to 10 grown. Feathers of spinal tract growing.

Stage 12 Postnuptial molt completed.

A single specimen may be assigned to either stage 0 or stage 12 for purposes of postnuptial molt analysis. In the consideration of molt data gathered from live birds, only 12 stages (0 to 11) are employed where stage 11 is assigned to birds which have completed the molt of flight feathers.

We have already seen (table 1) that first-year birds begin the postnuptial molt earlier than adults. First-year birds continued to be in a more advanced stage of molt than adults as long as the two age groups could be distinguished (fig. 5).

Inasmuch as first-year nutcrackers were not found to breed (Mewaldt, 1952), these data suggest that the breeding activity of the adults may have a delaying influence upon the start of molt. That this influence is not directly attributable to the gonads is highly probable (Leshner and Kendeigh, 1941; and Damsté, 1947). It should be noted that castrates of several species of birds have been found to molt (Keck, 1934; Witschi, 1935; and Domm, 1939). Except for a treatment of the influence of increased photoperiod upon molt, the physiological mechanism controlling molt is beyond the scope of this investigation. Some quantitative data, however, obtained from wild Clark's Nutcrackers, should prove suggestive in an interpretation of the relationship between the reproductive cycle and the postnuptial molt. These data are:

Nc 73, an incubating female with an incubation patch, was collected in the early afternoon of April 23, 1947, on Mitouer Ridge near Missoula, Montana. This female and her mate, Nc 72, started building a nest on April 15 and were observed still carrying material on April 17. The ovary, which weighed 436 milligrams, contained three freshly ovulated follicles. No other follicles were large enough to indicate further laying. The nest could not be reached for verification by egg count. The empty oviduct weighed 5050 milligrams. The postnuptial molt was in progress: right primary 1 was three centimeters long, right primary 2 was missing, and left primary 1 was missing.

Nc 72, a male with incubation patch, was collected an instant before his mate, Nc 73, on April 23, 1947. The combined weights of the testes, which were producing mature sperm, totaled 1188 milligrams. The postnuptial molt was in progress; primaries 1 and 2 of both wings were new and nearly fully grown, and primary 3 of both wings was four centimeters long.

Nc 76, a banded female whose incubation patch was nearly gone, was collected on the morning of April 29, 1947, on Mitouer Ridge near Missoula, Montana. Her two surviving young had probably left the nest on the preceding day. This bird and her mate started nest building on March 11; eggs were deposited on March 19, 20, 21; three young hatched on April 7 and 8; and the two surviving young left the nest when about 20 days of age, probably on April 28. The ovary weighed 43 milligrams,

and the oviduct weighed 243 milligrams. On the day of collection, postnuptial molt was in progress; primaries 1 to 3 were new and fully grown on both wings, and primary 4 was missing from both wings.

Nc 222, a female with a heavy incubation patch, was collected on April 13, 1948, near Big Creek, in the Bitterroot Mountains, Ravalli County, Montana. Her nest contained three eggs which had been incubated about 11 days. The ovary weighed 93 milligrams and the oviduct 594 milligrams. No molt was in progress.

Nc 223, a male with a heavy incubation patch, was collected a few seconds after Nc 222 as it left the nest mentioned in the preceding paragraph. The combined weight of the two regressing testes was 518 milligrams. The postnuptial molt was in progress; primaries 1 and 2 of both wings were new and fully grown, new primary 3 of both wings was nine centimeters long, primary 4 of both wings was missing.

From these data two suggestions concerning the postnuptial molt may be made. First, the postnuptial molt in the adult Clark's Nutcracker may begin before the eggs are laid. Wright and Wright (1944) found, however, that male *Agelaius phoeniceus* began postnuptial molt when the testes had regressed to about 20 milligrams in combined weight from a maximum of about 900 milligrams. In the tropics, Moreau, Wilk, and Rowan (1947) found that one of three species of birds studied, a coly (*Colius striatus mombassicus*), is in continuous molt through the nesting season. The other two, *Pycnonotus xanthopygus micrus* and *Phyllastrephus flavostriatus tenuirostris*, have a more concentrated molt which starts while there are still active spermatozoa in the testes. Miller (1955:503) reports in regard to birds in Colombia, South America, that molt "in many tropical species may take place when birds are in full breeding condition." The second suggestion concerning postnuptial molt is that males begin their postnuptial molt sooner than their mates. Olsen and Marsden (1951) found that male domestic white turkeys were induced to molt by exposure to long artificial days in winter whereas females showed no such response.

#### EXPERIMENTAL ALTERATION OF MOLT

Several species of finches, which normally undergo a prenuptial molt, have been induced to undergo a prenuptial-like molt by exposing them to increased photoperiods in autumn (Leshner and Kendeigh, 1941; Miller, 1948 and 1954; and Farner and Mewaldt, 1955). These finches, and several species which do not undergo a prenuptial molt, have responded to extended long photoperiods by undergoing a postnuptial-like molt (Walton, 1937; Burger, 1941; Vaugien, 1948; Wolfson, 1952; and Miller, 1954). A postnuptial-like molt has been induced in many species in spring or early summer by reducing the length of the daily photoperiod (Miyazaki, 1934; Burger, 1941; and Damsté, 1947).

#### EXPERIMENTAL MODIFICATION OF MOLT IN CLARK'S NUTCRACKER

*Experiment 1.*—A well ventilated, windowless room was used in which a constant photoperiod was provided. This room, which was about 13 feet long, 7 feet wide, and 8 feet high, was lighted by three 200-watt frosted incandescent electric lamps. Illumination for the final 15 minutes of each daily light period was provided by a seven and one-half watt lamp which enabled the birds to go to roost. Light readings, taken with a Weston Foot-Candle Meter (Model 614), varied from ten foot-candles on the darkest part of the floor to about 150 foot-candles on the higher perches. The nutcrackers received an average of from 40 to 60 foot-candles of light. The temperature of the air in this unheated room was about 0°C. when the roof aviary temperature was about -18°C., about 9°C. when the roof aviary temperature was 0°C., and about 26°C. when the roof aviary temperature was 21°C. The birds kept in this room received the same diet as those in the outdoor aviaries.

Ten nutcrackers were placed in this room on October 8, 1950, on an initial 12-hour

photoperiod, which approximated length of day on that date, including civil twilight. Seven and one-half minute decrements, alternating morning and evening, were applied until November 5, 1950, when an 8 1/2-hour photoperiod was attained. These birds remained on this reduced light ration until November 27, 1951, when the three remaining nutcrackers were moved to the roof aviary. These three birds started molting at the usual time near the end of March. They completed their molt of flight feathers nearly three months earlier than controls (see fig. 6). They also completed their molt more rapidly than they had the previous year when they underwent all but the initial stages of their first complete molt in outdoor cages where they received natural light.

*Experiment 2.*—Each large cage in the aviary on the roof of Science Hall was fitted

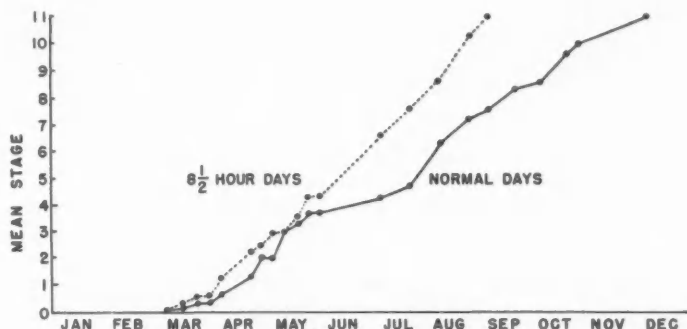


Fig. 6. Progress of molt of flight feathers of captive Clark's Nutcrackers on 8 1/2-hour days and on normal days in 1951.

with four 200-watt frosted incandescent electric lamps. Light intensity readings revealed that the darkest portions of the floor received eight foot-candles and the perches nearest the lamps in excess of 400 foot-candles. The nutcrackers received an average illumination of from 30 to 50 foot-candles from the lamps, plus natural illumination during daylight hours. The lights were regulated by an automatic time switch and were kept burning during daylight hours.

On October 14, when the time from sunrise to sunset at Pullman was approximately 11 hours, supplemental lighting was begun in the morning to produce an initial period of 12 hours. This photoperiod was increased by approximately 7 1/2 minutes each day, alternating morning and evening, until November 15, when a 16-hour photoperiod was attained. The lights in the cages were extinguished 15 minutes before the end of the photoperiod and a 100-watt bulb suspended in the center of the aviary was left lighted for the final 15 minutes to provide artificial twilight for the birds to go to roost. The 16-hour photoperiod was maintained until February 20, 1951, when the period of lighting was reduced by 15-minute daily decrements until March 7, when artificial lighting was discontinued. The first sign of molt occurred on December 19 when one of 20 nutcrackers dropped two primaries. The testes of this male were in the resting stage (testis stage 1) when it was sacrificed on December 27. Primary 1 had grown five centimeters and primary 2, four centimeters.

The sequence of prematurely induced molt did not follow the postnuptial molt pattern in four of the eight cases in which molt appeared. In these four, molt began with secondary 8 and usually involved secondaries 7 and 9, and rectrices 1-1 to 3-3 before

Table 2

Summary of Molt of Flight Feathers Induced by 16-hour Daily Photoperiods  
During Winter of 1950-51

Date	Number of birds	Number in molt	Stages (and number in each)	Mean stage	Adjusted mean stage*
Dec. 19	20	1	0(19), 1(1)	0.1	0.1
Dec. 27	16	1	0(15), 1(1)	0.1	0.1
Jan. 6	14	3	0(11), 1(3)	0.2	0.2
Jan. 13	14	4	0(10), 1(4)	0.3	0.3
Jan. 20	13	5	0(8), 1(5)	0.4	0.4
Jan. 27	12	5	0(7), 1(3), 2(2)	0.6	0.6
Feb. 3	8	6	0(2), 1(5), 2(1)	0.9	1.2
Feb. 10	8	6	0(2), 1(4), 2(2)	1.0	1.3
Feb. 16	8	6	0(2), 1(3), 2(3)	1.1	1.5
Feb. 25	8	6	0(2), 1(2) 2(2), 3(2)	1.5	2.0
Mar. 4	7	5	0(2), 1(1) 2(1), 3(3)	1.7	2.4
Mar. 11	7	5	0(2), 2(2) 3(2), 4(1)	2.0	2.8
Mar. 17	7	5	0(2), 2(2) 3(2), 4(1)	2.0	2.8
Mar. 24	6	4	0(2), 2(1) 3(2), 4(1)	2.0	3.0
Mar. 30	6	4	0(2), 2(1) 3(1), 4(2)	2.2	3.2
Apr. 7	6	4	0(2), 2(1) 4(2), 5(1)	2.5	3.7

\* Excludes two birds which failed to molt although they were held until April.

primary 1 was molted. One of the four started to molt between January 6 and 13 and had new secondaries 7 to 10; it had all new rectrices when sacrificed on April 26. This bird had no further molt of flight feathers. In those cases in which the molt pattern was irregular, molt stages were assigned in accordance with the number of flight feathers dropped so that graphic comparisons could be made with control groups. No molt occurred in two of the nutcrackers retained until April.

Table 2 gives a summary of the molt of the nutcrackers on 16-hour days in the winter of 1950-51, and figure 7 compares these data with the molt of the controls for the same period. None of the birds sampled showed any sign of gonadal recrudescence. It is probable that photoperiods were increased during the gonadal refractory period of the species.

*Experiment 3.*—On November 27, 1951, the three nutcrackers from experiment one and three which had been a part of the control group since April, 1950, were moved into individual cages in the open air aviary on the roof of Science Hall. These individual cages measured 24 inches long, 14 inches wide, and 18 inches high. The six cages were placed in a frame which gave some protection from rain and snow and which was lighted with incandescent electric lamps. Cage floors received from 50 to 65 foot-candles illumination and perches from 85 to 120 foot-candles. The diet remained unchanged from previous experiments, except that these six birds had piñon seeds constantly available. They had also been receiving these seeds daily during the preceding month.

On November 27, the nutcrackers received an 11-hour photoperiod; on November 28, they received 12 hours of light, and on November 29, they received 14 hours. The



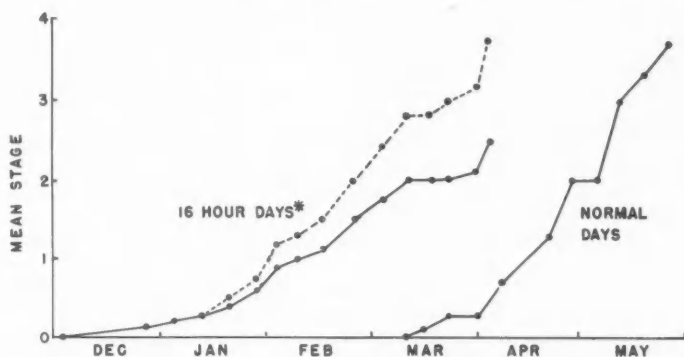


Fig. 7. Progress of molt of flight feathers of captive Clark's Nutcrackers on 16-hour days and on normal days in the winter of 1950-51. (\*Two birds which failed to molt are excluded from consideration in the broken line.)

final 15 minutes of the photoperiod again consisted of artificial twilight provided by a 100-watt bulb in the center of the aviary. The 14-hour photoperiod was continued until the six were sacrificed on December 30, 1951.

These six nutcrackers had undergone two previous complete molts in captivity. One of the six had started to molt on December 30 when the six were sacrificed for gonad examination. This bird, a male which had previously been on 8½-hour days, carried a new left primary 1, four centimeters long, and the right primary 1 was missing. Molt must have begun about December 24. The testes of this bird were enlarged and in full breeding condition.

#### DISCUSSION OF RESULTS

These experiments indicate that Clark's Nutcracker will molt while subjected to daily photoperiods of 8½, 14, or 16 hours. Molt on the 8½-hour photoperiods (experiment 1) started at the normal time, whereas on each of the two longer photoperiods (experiments 2 and 3) molt occurred more than two months ahead of the normal time.

It is perhaps significant that the nutcrackers on the 8½-hour photoperiod molted at the normal time. The time of molt was not changed by having the daily photoperiod reach winter minimum more than a month before the shortest day of the year. The physiological mechanism which timed the start of molt, therefore, was not immediately dependent upon changing photoperiod for its precision. However, Wolfson (1952) reports that some *Junco hyemalis* and *Zonotrichia albicollis*, placed on constant 9- and 12-hour daily photoperiods on December 4, did not molt in the course of an experiment which continued into the following fall. It is unlikely that molting in all groups can be expected to show a similar response to similarly altered photoperiods.

Changes brought about by caging birds for observation have a greater or lesser effect upon the molt, apparently depending upon how great or how little the environment varies from natural conditions. The molts of captive controls are usually extended in time, while the molts of birds subjected to various experimental procedures may not only be changed in duration but also in time of occurrence, extent, and/or sequence (Miller, 1954). Although light has been demonstrated to have an important effect upon molt in captive birds, the manner in which light exerts this effect is not apparent. Light is employed as a modifying factor in the forced molting of chickens by producers of poul-

try products. Here restriction of movement, reduction of drinking water, and changes in diet are widely employed to induce molt, with an apparent reduction in mortality (Hall, 1946).

Pitelka (1958) suggests that the annual molt in Steller's Jay resident on the Queen Charlotte Islands (latitude  $54^{\circ}\text{N}$ ) may be timed to take advantage of peak summer food abundance. He suggests that molting, with its high energy requirements for both adults and immatures, may be as critical, or more critical, in the survival economy of the species than the timing of feeding of nestlings. Consistent with this suggestion is his observation that Steller's Jays on the Queen Charlotte Islands molted earlier in the year and over a shorter period of time (60–80 days) than did Steller's Jays in the San Francisco Bay region of California (latitude  $38^{\circ}\text{N}$ ).

In Clark's Nutcracker in central western Montana (latitude  $47^{\circ}\text{N}$ ) the molt of flight feathers takes 135 to 150 days. Including the replacement of body feathers, the molt may take as long as 240 days. Superficially these data suggest a somewhat different adaptation in Clark's Nutcracker than Pitelka suggests for Steller's Jay. Molt in the nutcracker is apparently independent of any peak or peaks in food abundance. By being spread over all of the warmer months of the year, molt can progress with little more food than is required for life processes other than molt. We should observe, however, that molt of body feathers becomes heaviest in June, July, and August, when protein foods form a more important part of the diet than during the rest of the year. It may also be observed that replacement of body feathers in the warmer months places less strain on thermoregulatory processes than would such a replacement in the colder months of the year.

In Clark's Nutcracker in central western Montana, breeding is apparently dependent on an adequate supply of seeds from the ponderosa pine (Mewaldt, MS). In 1948, when food was scarce, molt in nonbreeding adults was fully a month later than in 1947 and 1949 when breeding was general. Here we see that, although delayed, molt occurred even when food was not sufficient to stimulate breeding. The reasons for this retardation are not immediately apparent, for first-year birds, which do not breed (Mewaldt, 1952 and MS), molt substantially earlier than adults (fig. 5). That the annual molt can be influenced in its timing by some factor in the reproductive cycle seems likely. However, it is equally apparent that there is no close dependence of molt upon reproduction in Clark's Nutcracker for we have observed that: (1) breeding birds may start postnuptial molt before their eggs are laid; and (2) some, but not all, captive birds, whose gonads failed to respond to increased photoperiods, were forced into an early postnuptial-like molt.

#### AGE HETEROMORPHISM AND SEXUAL DIMORPHISM

Male and female Clark's Nutcrackers do not appear to have external morphological differences except in size. Although males are on the average larger than females, the smaller males are smaller than the larger females.

In his detailed treatise on American jays of the genus *Aphelocoma*, Pitelka (1951) concluded that no absolute differences in external characteristics occur between the sexes but that, within each race, females are on the average smaller and duller than males.

Dosse (1937) found no correlation between sex and relative skeletal weight in six species of European Corvidae. He reported that the bones of older birds were heavier than those of younger birds (observations based in part on species other than Corvidae) because the water content of the bones declined coincident with an increase in the deposition of salts.

## AGE HETEROMORPHISM

Clark's Nutcrackers held in the hand, and to a more limited extent when seen in the field under favorable conditions for observation, can be separated into three classes by plumage characteristics. Most of the characteristics employed are applicable to other species of Corvidae (Emlen, 1936; Pitelka, 1945; Mayaud, 1948) and to a lesser extent to species in some other families of Passeriformes.

A number of external characteristics can be employed to assist in the separation of juvenal, first-year, and adult Clark's Nutcrackers. Usually more than one characteristic is needed to estimate the age of a specimen. The presence or absence of the bursa of Fabricius and, to a more limited extent, the degree of cranial ossification (Miller, 1946; Nero, 1951) are useful, especially during the fall and winter months, to confirm age assignments made on plumage characteristics.

*Heteromorphism of external characteristics.*—The following external characteristics were found useful for separating juvenal Clark's Nutcrackers from first-year and adult birds. Descriptions of color when capitalized have been taken from Ridgway's (1912) "Color Standards and Color Nomenclature."

1. The gray eyes of the nestling have changed to brown about six weeks after hatching.
2. The gray coloration of the feet, including the tarsus, of the nestling has changed to black about six weeks after hatching.
3. On leaving the nest, the inside surfaces of the bill and mouth are white. Small areas with black pigmentation soon appear. These pigmented areas usually spread until the entire inside surfaces of the bill and mouth become black in the fall months.
4. The feathers in the facial area around the bill of juveniles are of the same color as those of the rest of the head. The feathers of this facial area become white in the postjuvenal molt and are white in all subsequent plumages.
5. The juvenal body feathers are Mouse Gray usually broadly tipped with Pale Ochraceous-Buff, in contrast to the pure Mouse Gray of the body feathers of first-year and adult birds.
6. Juvenal body feathers are typically fluffy, or less compactly formed than the body feathers of first-year and adult birds.
7. Except for occasional accidental feather losses, young birds of a given year do not molt their flight feathers until about one year old. Most first-year and adult nutcrackers have flight feathers in molt in May, June, July, and August, the months when nutcrackers in juvenal plumage are present.

After the postjuvenal molt another set of characteristics is necessary to distinguish first-year birds from adults. Most of these are the result of the incompleteness of the postjuvenal molt. Usually in July of their second year, first-year birds can no longer be distinguished from adults.

1. Pigmentation of the first-year remiges and rectrices is usually weak. These flight feathers tend to become brownish in the fall and winter. Although adult remiges and rectrices show some fading by spring, they are usually substantially darker than those of first-year birds taken at about the same time of year.
2. Juvenal alular feathers, greater primary coverts, greater secondary coverts, and middle secondary coverts retained through the postjuvenal molt tend to be dull and brownish. These stand out in contrast to the renewed marginal coverts and what middle and occasional greater secondary coverts are renewed. The renewed coverts are glossy blue-black.
3. The tips of the rectrices of first-year nutcrackers tend to be rounded, whereas those of adults are usually truncate.
4. Primaries 5 to 9 of first-year birds tend to have their tips more pointed than the same primaries of adults.
5. Remiges and rectrices, especially their terminal portions, of first-year birds usually appear more worn than do those of adults at a given time of the year.

The characteristics enumerated above were employed to place each specimen into an age group before dissection was made. In only two or three instances did inspection

of the internal anatomy force a revision of the age assignment originally based upon the external characteristics.

In addition, differences among the age groups were found in weight, wing length, tail length, length of exposed culmen, and height of the bill at the angle of the gonys.

*The bursa of Fabricius.*—The occurrence, structure, and ontological history of the bursa of Fabricius in many species of birds, including certain species of Corvidae, have been considered at length by Forbes (1877), Retterer (1885), and Jolly (1915). The practical use of the bursa to ascertain age in upland game birds is discussed by Gower (1939), Linduska (1943), and Kirkpatrick (1944). During the fall hunting season the bursa is present in birds-of-the-year of most upland game species and it is absent from older birds.

In Montana, Wright and Wright (1944) found that the bursa of Fabricius was present in "year-old" Redwinged Blackbirds (*Agelaius phoeniceus*) in January but absent in March. Adults did not have a bursa. Schwartz and Schwartz (1950) found the bursa of Fabricius present in some Barred Doves (*Geopelia striata*) in both juvenal and adult plumages in Hawaii. However, they also found the bursa absent from some Barred Doves in both plumages.

Each nutcracker collected was carefully examined for a bursa of Fabricius. All juveniles were found to have a bursa. Table 3 shows the occurrence of the bursa in 162 juvenal and first-year nutcrackers. The actual numbers of birds having a bursa in the late winter and early spring months was probably somewhat higher. In the late winter of 1946-47 and in the early spring months of 1947, I experienced some difficulty in recognizing the bursa when it was small and surrounded by fatty tissue.

Table 3

Frequency Distribution of Weights of the Bursa of Fabricius of Juvenal and First-year Clark's Nutcrackers by Months After Hatching

Month	Number of birds	Bursa not found	Weight of bursa in milligrams							
			1 to 50	51 to 100	101 to 150	151 to 200	201 to 250	251 to 300	301 to 350	More than 350
Apr.	1	.....	.....	.....	.....	.....	.....	1	.....	.....
May	20	.....	.....	1	3	3	7	4	2	.....
June	3	.....	.....	.....	.....	1	.....	.....	1	1 <sup>1</sup>
July	8	.....	.....	.....	1	1	4	2	.....	.....
Aug.	4	.....	.....	.....	1	.....	2	.....	.....	1 <sup>2</sup>
Sept.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oct.	6	.....	1	.....	1	3	.....	.....	1	.....
Nov.	14	.....	.....	2	6	4	.....	1	1	.....
Dec.	7	2	1	1	2	1	.....	.....	.....	.....
Jan.	14	1	6	5	2	.....	.....	.....	.....	.....
Feb.	15	4	3	6	2	.....	.....	.....	.....	.....
Mar.	35	20	8	3	3	1	.....	.....	.....	.....
Apr.	18	12	6	.....	.....	.....	.....	.....	.....	.....
May	11	9	2	.....	.....	.....	.....	.....	.....	.....
June	3	3	.....	.....	.....	.....	.....	.....	.....	.....
July	3	2	1	.....	.....	.....	.....	.....	.....	.....
Aug.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sept.	1	.....	1 <sup>3</sup>	.....	.....	.....	.....	.....	.....	.....

<sup>1</sup> 403 milligrams.

<sup>2</sup> 588 milligrams.

<sup>3</sup> Male in adult plumage presumed to have been about 18 months old.

The frequency distribution of the weights of alcoholic specimens shown in table 3 suggests that the bursa of Fabricius of Clark's Nutcracker begins to decrease in size in about October of the first year of the bird's life. By the following April, the bursa was found to weigh generally less than 50 milligrams or to be absent. One male (Nc 273) in adult plumage, collected on September 5, 1948, and thought to be about 18 months old, had a distinct bursa which weighed 38 milligrams.

*Skin measurements.*—The summary of measurements which follows is based upon my series of skins only. Methods of measurement were adapted from Baldwin, Oberholser, and Worley (1931) and may be described as follows:

1. Length of wing: The length of the folded wing was taken with dividers in millimeters from the proximal anterior surface of the first metacarpal portion of the carpometacarpus to the tip of the longest primary with the wing folded. This measurement approximates the length of wing from the bend to the tip of the longest primary with the wing folded, but it can be more accurately duplicated. Measurements were made on the right wing unless it was damaged, in which case the left wing was used.

2. Length of tail: The length of the tail was measured along its dorsal surface, to the nearest tenth of a millimeter, with the inside points of a vernier caliper. One point was placed between the middle rectrices where they emerge from the skin, and the other point was placed at the tip of the longest rectrix.

3. Length of exposed culmen: The proximal limit of the exposed culmen was determined with the inside surface of the thumb-nail. One of the inside points of a vernier caliper was placed against the back of the thumb-nail on the culmen and the other point was adjusted to the tip of the culmen. Readings were made to the nearest tenth of a millimeter. The thickness of the thumb-nail was not added to the reading.

4. Height of the bill at the angle of the gonys: A common pin was inserted through the first free skin in the angle of the gonys. The pin was firmly seated perpendicular to the ventral surface of the gonys. The outside arms of the vernier caliper were employed to take the height anterior to and touching the pin from the angle of the gonys to the top of the culmen. Measurement was taken to the nearest tenth of a millimeter.

Inspection of tables 4 and 5 makes it apparent that size differences do occur in the

Table 4  
Measurements in Millimeters of Clark's Nutcrackers by Age and Sex

Measurement	Age and sex	Number	Range	Mean	Standard deviation
Length of wing	Adult males	161	181-202	192	±4.3
	Adult females	90	180-199	186	±4.3
	First-year males	75	178-197	187	±4.2
	First-year females	64	173-193	181	±3.8
Length of tail	Adult males	163	104-124	115	±3.8
	Adult females	87	103-117	111	±3.4
	First-year males	68	103-116	109	±3.1
	First-year females	60	100-112	105	±3.3
Length of exposed culmen	Adult males	184	34.8-47.8	40.1	±1.8
	Adult females	96	34.3-42.8	37.7	±1.9
	First-year males	75	30.3-42.8	37.3	±2.9
	First-year females	65	30.3-39.8	36.0	±2.3
Height of bill	Adult males	180	10.0-12.3	11.0	±0.4
	Adult females	95	9.4-11.4	10.5	±0.4
	First-year males	75	7.8-11.8	10.5	±0.8
	First-year females	71	7.3-11.2	10.2	±0.7

Table 5

A Summary Showing Possible Comparisons of Means of Some External Measurements of Clark's Nutcrackers

Compare means	Is the difference between means in table 4 very significant? ( $P = 0.003$ )			
	Length of wing	Length of tail	Length of culmen	Height of bill
Adult males with adult females	Yes	Yes	Yes	Yes
Adult males with first-year males	Yes	Yes	Yes	Yes
Adult males with first-year females	Yes	Yes	Yes	Yes
Adult females with first-year males	No	Yes	No	No
Adult females with first-year females	Yes	Yes	Yes	Yes
First-year males with first-year females	Yes	Yes	Yes	No

age and sex groups of Clark's Nutcracker. Table 5 presents a summary of statistical analyses made to determine whether the means (with their standard deviations) are real, or if they could have arisen by chance. A "yes" in table 5 implies that there is less than 1 chance in 300 that another sample from the same population would not show similar differences in means. Adult males have longer wings, tails, and exposed culmens, and a greater height of bill than any other age and sex group. First-year females are smaller in each of these measurements than the other age and sex groups. Measurements of adult females and first-year males, on the other hand, approach each other very closely. No significant difference was found between the heights of the bills of first-year females and first-year males.

#### SUMMARY

From October, 1946, to October, 1951, a total of 439 Clark's Nutcrackers (*Nucifraga columbiana*) was collected. Most of these birds were taken in western Montana. An additional 65 were live-trapped and used in an investigation of the effects of altered photoperiods on the molting process.

In its pterylography, Clark's Nutcracker was found to be very similar to *Aphelocoma coerulescens* as described by Pitelka (1945) and to other species of Corvidae as described by other authors. The middorsal apterium was found present in representatives of nine genera of Corvidae examined (including *Nucifraga columbiana*) and absent from representatives of five genera. The outer pair of upper tail coverts (6-6) may be gradually disappearing from some species such as *Nucifraga columbiana* and may be the pair already lost from some other species such as *Aphelocoma coerulescens*.

The postjuvenile and postnuptial molts of Clark's Nutcracker are apparently very similar to the molts reported for other passerine species including *Aphelocoma coerulescens* and *Corvus frugilegus*. First-year Clark's Nutcrackers commence their first postnuptial molt in the first half of March, whereas most adults did not start their postnuptial molt until late March or early April. As long as the two age groups can be distinguished (until July), first-year birds are generally in a more advanced stage of molt than adults. Between March 31 and September 1, 91 per cent of 174 first-year and adult birds collected showed molt of flight feathers, indicating that individual nutcrackers take four and one-half or five months to replace their remiges and rectrices. Between March 31 and December 1, 93 per cent of 243 first-year and adult nutcrackers collected were molting flight feathers or body feathers, suggesting that individual nutcrackers are in molt for eight or nine months. February was the only month in which all specimens collected were free of molt. Postnuptial molt usually begins in this species while the gonads are still in breeding condition and may begin before eggs are deposited in the nest.

In an unheated room three Clark's Nutcrackers which had been receiving 8½ hours of artificial light daily for more than four months began a postnuptial-like molt at the usual time in March. In an outdoor aviary eight nutcrackers were induced to begin a postnuptial-like molt in December and January by exposure in November, December, and January to daily photoperiods of 16 hours. Controls on a normal photoperiod began molting at the usual time in March and April. No gonadal recrudescence was observed to precede or accompany this postnuptial-like molt in controls or experimentals.

A series of plumage differences are enumerated which may be used to distinguish juvenal Clark's Nutcrackers from first-year and adult birds, and to distinguish first-year birds from adults. Most of these differences stem from two observations: (1) juvenal flight feathers are usually less heavily pigmented, and tend to be more pointed than adult flight feathers, (2) flight feathers and many of their coverts are retained through the postjuvenal molt.

All juvenal Clark's Nutcrackers were found to have a bursa of Fabricius. From a maximum of about 300 milligrams the bursa begins to decrease in weight usually by October of the bird's first year. By the following April, the bursa was found to weigh generally less than 50 milligrams, or to be absent.

Adult males were found to have longer wings, tails, and exposed culmens, and a greater height of bill, than adult females, first-year males and first-year females, while first-year females were smaller in each of these measurements than the other age and sex groups. Measurements of adult females and first-year males, on the other hand, approached each other very closely. Although, on the average, males are larger than females, the larger females are larger than the smaller males.

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## BIRDS OF KURE ATOLL, HAWAII

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At 9:00 a.m. on June 5, 1957, we landed on Green Island, Kure Atoll, west of Midway, and spent nine hours ashore. Previously we had made four low-altitude aerial surveys of the atoll on December 9 and 21, 1956, and on February 12 and May 14, 1957. The only other recorded visit by biologists to this remote atoll was that of the Tanager Expedition in 1923, when a party of five, under the direction of Alexander Wetmore, worked for several days on Green Island. No report on the birds obtained has been published.

Our visit to Kure Atoll was part of a study of breeding populations of oceanic birds conducted from 1956 to 1957 by the United States Fish and Wildlife Service and sponsored by the United States Navy. We wish to acknowledge the cooperation extended by Capt. E. T. Hughes, Commanding Officer of the Midway Islands Naval Station, who authorized the Kure Atoll trips. We also wish to extend our appreciation to Lt. Cdr. J. F. Reilly, who was in charge of the expedition; his interest in our work made it possible for us to spend sufficient time ashore. Dr. John W. Aldrich and Mr. Chandler S. Robbins of the Bureau of Sport Fisheries and Wildlife participated in the first aerial survey.

Kure Atoll is the most westerly land in the Leeward Islands, a chain which extends for 1200 miles northwest of the main Hawaiian Islands. Its position is latitude  $28^{\circ} 25'N$ , longitude  $178^{\circ} 25'W$ ; it is 56 nautical miles northwest of Midway Atoll. Kure is a typical atoll with a nearly circular barrier reef enclosing a lagoon which is six miles in diameter. Other than a few shifting sandspits, the only land area is Green Island, which lies just inside the southeast reef. The island is roughly crescent-shaped, sandy, and it is over one mile long and less than one-half mile wide. Behind the sand beaches, spreading inland from the crests of 10- to 20-foot dunes, is an almost impenetrable growth of *Scaevola frutescens*, broken only by an opening of several acres, carpeted by low herbaceous vegetation, in the interior. A radar reflector tower has been erected by the Navy on the northwest side of the island. A more detailed description of Kure Atoll may be found in Bryan (American Polynesia and the Hawaiian Chain, 1942:204).

No land birds inhabit Green Island. The only terrestrial mammals are rats. *Rattus exulans* was the species collected by members of the Tanager Expedition. Dr. David H. Johnson of the United States National Museum suggests that possibly *Rattus rattus* may have been subsequently introduced and that it has replaced *exulans*. In 1923 the island was "overrun with rats." They are not common now; we saw only one during our visit. Monk seals (*Monachus schauinslandi*) regularly use the beaches as hauling grounds.

## ANNOTATED LIST OF SPECIES

We attempted to record quantitative information on the local breeding populations of the oceanic birds observed. The following list includes all of the species seen. Unless otherwise stated, the observations were made on the ground survey of June 5. Several other species could doubtless be found at other seasons or by more intensive search. The estimated populations of sea birds resident in 1957 are summarized in table 1.

*Diomedea nigripes*. Black-footed Albatross. This species nests only on beaches or on bare sand. On June 5 virtually all the young were on the open beaches; therefore, our count is probably very near the actual total. We counted 14 chicks along the south beach and 28 along the north beach of the island, or a total of 42 young. We doubtless missed a few, so perhaps 50 young were present. Judging from the mortality caused by wind-driven sand in the course of winter storms at Midway Atoll early in the nesting season, there must have been about 40 per cent more albatross nests on Kure Atoll,

Table 1

Estimated Resident Sea Bird Populations on Green Island, Kure Atoll, in Spring, 1957

Species	Nesting pairs	Total adults
Black-footed Albatross ( <i>Diomedea nigripes</i> )	70	163
Laysan Albatross ( <i>Diomedea immutabilis</i> )	345	805
Wedge-tailed Shearwater ( <i>Puffinus pacificus</i> )	common?	common?
Red-tailed Tropic-bird ( <i>Phaethon rubricauda</i> )	500	1000
Blue-faced Booby ( <i>Sula dactylatra</i> )	80	170
Brown Booby ( <i>Sula leucogaster</i> )	30	70
Red-footed Booby ( <i>Sula sula</i> )	240	500
Great Frigate-bird ( <i>Fregata minor</i> )	100	325
Gray-backed Tern ( <i>Sterna lunata</i> )	?	8
Sooty Tern ( <i>Sterna fuscata</i> )	?	3
Noddy Tern ( <i>Anous stolidus</i> )	66	252
White-capped Noddy Tern ( <i>Anous tenuirostris</i> )	?	44
Fairy Tern ( <i>Gygis alba</i> )	?	1

or a total of about 70 breeding pairs. A group of 64 adult Black-footed Albatrosses was photographed from the air on the bare sand point at the western end of the island on December 21. We could not determine whether they were nesting. In June we found no Black-footed Albatrosses on this point. At that time, we saw only about 10 adults, mostly unemployed birds (Richdale, Sexual Behavior in Penguins, 1951:7), on the island. Judging from conditions on Midway Atoll, the number of unemployed birds should equal at least one-sixth of the number of breeding birds. Including 23 unemployed birds, our estimated total for adults present this season was 163.

*Diomedea immutabilis*. Laysan Albatross. We counted all chicks that could be seen on June 5. In the interior open area of the island, there were 172 chicks; along the south beach, 35; along the north beach, 63; thus we recorded a total of 270 chicks. We doubtless missed a number, so probably about 300 chicks were present. Allowing for a 15 per cent mortality, based on data from Midway, there must have been approximately 345 nests at the beginning of the season. Most of the chicks along the beaches were on the open sand; a few were found under the *Scaevola* shrubs fronting the beach. At a number of points, we made a thorough search into the dense *Scaevola* thickets. It was obvious that no Laysan Albatrosses could nest there since albatrosses nesting in the open interior had to fly in and out over the impenetrable barrier of *Scaevola* which prevented them from walking to the beach. It is possible that this fact accounts for the low population of albatrosses in an otherwise suitable habitat. We found several albatross skeletons in the *Scaevola* thickets. Probably they were from newly-fledged birds not yet proficient in flight which had inadvertently landed, become entangled, and starved to death in the thickets. A partial count, plus estimates for others seen, indicated that 75 to 100 adult birds, mostly unemployed, were on the island. There should have been at least 115 unemployed Laysan Albatrosses using Green Island this season, if we assume that the ratio from sample counts made on Midway can be applied here. Our estimate for the total number of adults using the island was 805.

*Puffinus pacificus*. Wedge-tailed Shearwater. We saw numerous burrows of this species in the interior open area. At daybreak, and also in the evening, Wedge-tailed Shearwaters were fairly numerous two to 20 miles offshore.

*Phaethon rubricauda*. Red-tailed Tropic-bird. Nesting tropic-birds were fairly common in the *Scaevola* scrub, but they were not as abundant as they are on Midway Atoll. A concentration of 70 to 80 were participating in aerial display over the western section of the island. We would guess their abundance at about 500 pairs. At sea we saw several single birds and a few small groups.

*Sula dactylatra*. Blue-faced Booby. We counted 80 nesting pairs in a loose colony on the interior open area. We found no nests elsewhere. Since Blue-faced Boobies characteristically nest in the open, we believe that we saw all the nests. A few nests contained two eggs; the majority contained single young birds ranging in development from newly-hatched to nearly-fledged. We saw a few birds in immature plumage, so we estimated that 170 birds, exclusive of nestlings, were present.

*Sula leucogaster*. Brown Booby. In the interior open area, we counted 27 nests. Of 13 examined

closely, two held one egg, five held two eggs, one held two newly-hatched chicks, and five held single chicks, the largest of which were half grown and still covered with white down. Since these birds often nest under *Scaevola* at Midway Atoll, it is possible that we missed nests, so we have estimated a total of 30 nests. A few birds in immature plumage were observed. The total, excluding nestlings, must have been at least 70.

*Sula sula*. Red-footed Booby. These boobies were nesting over much of the scrub-covered area, mainly in the higher *Scaevola* clumps. We counted them from the top of the radar reflector tower, from which the entire island is visible; there were 218 presumably nesting pairs. We believe that this count included about 90 per cent of the nesting population, indicating a total of about 240 nests. All nesting birds were in white plumage. We saw several birds in brownish or mottled immature plumage. The total population, excluding nestlings, must have been close to 500.

*Fregata minor*. Great Frigate-bird. Although frigate-birds perched in the *Scaevola* over most of the northeastern two-thirds of the island, there appeared to be three concentrations, probably nesting colonies, between the interior open area and the southeast beach. We made observations through binoculars from the top of the radar reflector tower and counted 210 frigate-birds resting on bushes and 115 in the air, a total of 325. While time did not allow us to penetrate the tangled *Scaevola* around the colonies, we estimated that there were about 100 nests. No males with distended gular sacs were seen. This indicated that the courtship phase of the breeding cycle had passed.

*Pluvialis dominica*. American Golden Plover. Two birds in winter plumage were seen along the north shore.

*Arenaria interpres*. Ruddy Turnstone. Three were seen along the north beach.

*Heteroscelus incanum*. Wandering Tattler. We captured one extremely emaciated individual in winter plumage, unable to fly, on the north beach.

*Sterna lunata*. Gray-backed Tern. Five flew over the north beach and three crossed the interior open area. No nests were found.

*Sterna fuscata*. Sooty Tern. Three birds flew over the island. We found no nests. The absence of flat open nesting habitat may explain the scarcity of this species. At this season, incubation was already well under way in the large colonies at Midway Atoll. Many Sooty Terns flew near the ship in the waters off Kure Atoll.

*Anous stolidus*. Noddy Tern. We counted 15 birds on the west point, 40 along the south shore, 107 on the northeast point, and 90 along the north shore, a total of 252. Six nests were found on the west point, about 20 along the south beach, and about 40 at the northeast point, a total of about 66 nests. All nests were among chunks of broken coral on the open beaches. Several eggs examined were fresh; we saw no young.

*Anous tenuirostris*. White-capped Noddy Tern. A flock of 40 rested on the north beach; in addition, we saw one on the south beach, another on the west point, and two on the northeast end of the island. There was no indication of nesting.

*Gygis alba*. Fairy Tern. The only one seen was flying one-half mile outside the reef. We saw a few in flight over the ocean within 20 miles of the atoll. Since Fairy Terns are at the height of nesting at this season on Midway, it seems likely that the birds at Kure Atoll may nest on the large protruding rocks of the barrier reef, as they are known to do elsewhere.

*United States Fish and Wildlife Service, Washington 25, D.C., September 19, 1957.*

## FROM FIELD AND STUDY

**Reddish Egret and Bronzed Cowbird in California.**—An immature Reddish Egret (*Dichro-manassa rufescens*) was obtained at the mouth of Chemehuevi Wash, along the shore of Havasu Lake, San Bernardino County, California, on September 9, 1954. It had been seen at the same place five days earlier. Although there are a few reliable sight records for California, this is the first specimen. It is now in the Museum of Vertebrate Zoology (No. 135902).

An adult female Bronzed Cowbird (*Tangavius aeneus*) was taken at the McDougal-Warner Ranch, adjacent to the small settlement of Bard, Imperial County, California, May 12, 1955, with the assistance of Bruce K. Harris. It is the first specimen from the state, and it is also in the Museum of Vertebrate Zoology (No. 135903). Earlier, on April 30, 1955, two males were seen at the same place by Burt L. Monroe, Jr., and the writer. I have previously reported seeing this species in the state (Condor, 56, 1954:229).—GALE MONSON, Yuma, Arizona, November 22, 1957.

**Blue Goose Observed at the Salton Sea, Imperial County, California.**—On December 14, 1957, Edward J. O'Neill, of the United States Fish and Wildlife Service, and I were observing a large flock of Snow Geese (*Chen hyperborea*) on a large fresh water pond near the southern end of the Salton Sea National Wildlife Refuge, Imperial County, California. While we were watching the geese a single engine civilian aircraft flew over the area at a moderate elevation. As the airplane approached, the geese rose en masse, wheeled about the area, and returned to the pond.

When the flock landed, Mr. O'Neill noted a darker goose on a bank about 200 yards from us. Using a 20× spotting scope we identified this bird as a Blue Goose (*Chen caerulescens*). This goose was observed for the better part of an hour. At first it was at the edge of the group of Snow Geese on the bank, but after a half hour it joined the Snow Geese and was finally lost in the middle of the flock.

According to Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:72), the Blue Goose "is a rare winter visitor to the San Joaquin-Sacramento Valley. Two occurrences have been definitely recorded." One of these was near Stockton on about February 1, 1892, and another specimen was taken in the vicinity of Gridley, Butte County, on December 15, 1910. A check through subsequent literature available to me shows no further records of this species for California.—JAMES R. SAMS, Natural History Museum, San Diego, California, December 19, 1957.

**The Subspecific Identity of the Oystercatcher in Uruguay.**—Hellmayr and Conover (Cat. Birds Amer., pt. 1, no. 3, 1948:21) designate Santa Catharina, Brazil, as the southern limit of the distribution of *Haematopus ostralegus palliatus*. The same authors (*op. cit.*: 24) affirm the existence of the subspecies *durnfordi* on the Uruguayan coast, ranging southward to southern Argentina (Deseado). G. W. Teague (Com. Zool. Mus. Hist. Nat. de Montevideo, 4, no. 72, 1955:4-5) lists sight records of the species obtained in Cabo de Santa María, on the beaches of La Paloma, Isla de la Tuna, and Isla Grande in the Department of Rocha, Uruguay. He considers the specimens seen to belong to the race *durnfordi*. However, Murphy (Oceanic Birds of South America, 2, 1936:976), noting the sight records published by Wetmore and Burmeister, says "this information gives no clue . . . as to the boundary between the ranges of the two Atlantic subspecies of South America, namely *palliatus* and *durnfordi*." Later on (*op. cit.*: 977), he adds: "In the absence of specimens, it is impossible to fix the identity of Oyster-catchers recorded from southern Brazil and Uruguay."

For a better understanding of the Oystercatchers found in Uruguay, I would like to present the results of a study of some specimens collected by me in the Department of Maldonado. On March 1, 1954, I obtained two Oystercatchers; one was collected in the peninsula of Punta del Este and the other 10 kilometers west in Punta del Chileno, near Laguna del Diario. The specimens taken were from small groups of six or eight. I observed these groups in the summers of 1953 and 1954. Apparently, these birds constituted a homogeneous population that was found from Barra del Arroyo Maldonado to Punta Ballena, including the beaches and rocks of Punta del Este and the islands of Gorriti and Lobos, along 20 kilometers of the Atlantic coast.

In the absence of comparative material I tentatively identified the specimens collected as *palliatus*. One was sent to Emmet R. Blake of the Chicago Natural History Museum. He reported that it should

be considered as *palliat*us, although it was not wholly typical of that form because of the slight intensification of its dorsal pigmentation.

On July 12, 1957, I saw twenty-six individuals along the coast of the peninsula of Punta del Este. The temperature at that time was below zero and was extremely low for that locality. I collected three specimens which I added to my private collection. One, an adult male, was sent as a gift to the Chicago Natural History Museum. Mr. Blake verified that this bird was also *palliat*us, as were the others.

Therefore, Uruguay may be included in the range of *H. o. palliat*us, and we may now consider this race as a permanent resident in this country. To what extent this subspecies intermingles with *durnfordi* may be demonstrated by future research.

I am grateful to the Chicago Natural History Museum and especially to Emmet R. Blake for the valuable assistance given me.—RODOLFO ESCALANTE, *Montevideo, Uruguay, November 11, 1957.*

**Snowy Plover Nesting on Lower Klamath Refuge, Siskiyou County, California.**—On June 21, 1957, an adult Snowy Plover (*Charadrius alexandrinus*), accompanied by one downy young, was seen on the 12-12A Dike near the south end of the Lower Klamath National Wildlife Refuge. This evidence of nesting is of interest in view of the fact that the Snowy Plover has in the past been seen locally so rarely that its status has been considered that of an accidental visitor. Jewett included this species in a general bird list for the Klamath Basin Refuges (Fish and Wildlife Service, Wildlife Leaflet 238). The only other record of the species from our files is an observation of one bird on June 11, 1954, on Tule Lake Refuge. Since the Tule Lake and Lower Klamath refuges are only three miles apart and are separated by a low ridge, the difference in locality is not considered significant from the standpoint of distribution.

Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:137) give the northernmost breeding record in California as near Eureka, Humboldt County. This is a coastal location. The same authors cite Dawson (Birds of California, 3, 1924:1314 ff) for the northernmost interior record, Goose Lake, Modoc County. Goose Lake is only 60 airline miles to the east of Lower Klamath. However, the record there is one of occurrence only; it is not a breeding record.

In the spring of 1957, units 12 and 12A of the Lower Klamath Refuge offered excellent shorebird habitat. These units had been drained late in the previous year, but neither could be drained completely. Each retained hundreds of acres of shallow pools interspersed with islands of higher ground. As evaporation and ground loss removed this residual water, broad expanses of mud flat were exposed. Large flocks of migrating dowitchers, Least and Western sandpipers, and Dunlin, as well as smaller numbers of Black-bellied Plovers were attracted to the area. In addition, a considerable population of resident shorebirds, including Killdeer, American Avocets, and Black-necked Stilts, became established and nested successfully prior to complete disappearance of the water.—LEROY W. GILES and BEN H. CRABB, *United States Fish and Wildlife Service, Tulelake, California, November 12, 1957.*

**Columba vitiensis anthracina (Hachisuka), a Reconsideration.**—In the course of a study of the birds of Mindoro, we have had occasion to examine two specimens of the Metallic Wood Pigeon (*Columba vitiensis*) from small islands off Palawan Island in the Philippines. The specimens are in the collection of S. Dillon Ripley.

One of them represents the type of *Janthoenas vitiensis anthracinus* Hachisuka, described in 1939 (Bull. Brit. Ornith. Club, 59:152) from Lumbucan Island, a subspecies not previously recognized in the literature on the birds of the Philippine Islands. A female from Comiran Island agrees with the type in differing considerably from the Philippine population, *C. v. griseogularis*. These specimens are darker below with the chin, cheeks, ear coverts, and upper throat dark, smoky gray, rather than whitish gray. The rest of the under parts are somewhat darker, and the forehead also is somewhat darker than in *griseogularis*. Other characters mentioned by Hachisuka, such as the lack of the purple tinge of *griseogularis* and the smaller size, do not seem to apply. These two specimens measure: wing, ♂ 236 mm., ♀ 230.5 mm. However, the difference in the throat is striking, and the birds bear a suggestive resemblance to the species *janthina* as pointed out by Hachisuka (*loc. cit.*: 153). This may indicate a relationship between the tropical *vitiensis* and the temperate *janthina* of the small islands of Japan, two species now combined by some modern authors.



Manuel (Phil. Jour. Sci., 63, 1937:176) had previously listed Lumbucan and Comiran islands as the home of typical *C. v. griseogularis* without comment. Unfortunately, the Bureau of Science specimens were destroyed in Manila during World War II. On the basis of these two specimens, we believe that it is valid to resurrect and recognize the name *anthracina* for the population of the Metallic Wood Pigeon from the small islands off Palawan, namely Lumbucan and Comiran, and presumably the neighboring islands.—S. DILLON RIPLEY and D. S. RABOR, *Peabody Museum of Natural History, Yale University, New Haven, Connecticut, October 8, 1957.*

**A White-winged Dove Record for Northern California.**—At 2:00 p.m., on September 14, 1957, I observed a White-winged Dove (*Zenaida asiatica*) as it flew across the Arcata-Samoa road one mile west of Arcata, California. The bird was about the size of a Mourning Dove and had noticeable white wing patches and white in its rounded tail.

Later, on November 8, 1957, a White-winged Dove was collected on the Arcata bottoms approximately four miles northwest of Arcata. The bird was seen to fly from a roadside marsh into a patch of teasel (*Dipsacus sylvestris*) where it was shot. The tail and wing feathers show no signs of wear similar to those of a bird that had been caged. The specimen is now in the Humboldt State College collection.

This appears to be the first record for this species from northern California. Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:77) refer to a record of a White-winged Dove that was seen five miles west of Watsonville, Santa Cruz County, in 1939; this is the northernmost record cited by these authors.—CHARLES F. YOCOM, *Division of Natural Resources, Humboldt State College, Arcata, California, November 19, 1957.*

**Occurrence of the Yellow-shafted Flicker in Northern California.**—On May 1, 1957, a single male Yellow-shafted Flicker (*Colaptes auratus*) was recorded on the Lower Klamath National Wildlife Refuge, Siskiyou County, California. This bird flushed ahead of my vehicle and flew across a wide canal to alight on the crest of the opposite bank. It remained there for several minutes, turning its head and hopping about rather nervously, before disappearing behind the farther slope. During the time the bird was in sight, it was observed through 20×60 binoculars secured to a vibration-free window clamp. With this magnification, and at a distance of only about 100 feet, every distinguishing feature was evident. The red triangle on the back of the head was conspicuous as were the yellow wing linings. When the flicker held its head at the proper angle the black "whiskers" could be plainly seen.

Grinnell and Miller (The Distribution of the Birds of California, Pac. Coast Avif. No. 27, 1944) list a number of records of this species for California. Most of these are from the southern part of the state, the northernmost being from Marin County, immediately north of San Francisco Bay. Gabrielson and Jewett (Birds of Oregon, 1940) give two records of this species in Oregon, both from the northwestern part of the state. One was from Portland and the second was from Tillamook County.—LEROY W. GILES, *United States Fish and Wildlife Service, Tulare, California, August 29, 1957.*

**A Nesting Record of the Scissor-tailed Flycatcher in Nuevo León, México.**—On July 19, 1954, I discovered a nest of the Scissor-tailed Flycatcher (*Muscivora forficata*) between Km. 1121 and Km. 1122 on the Monterrey-Nuevo Laredo highway in the state of Nuevo León, México. This locality is 32 kilometers by road north of the town of Sabinas Hidalgo and 25.5 kilometers south of the town of La Gloria.

Although Wolfe (Check-list of the Birds of Texas, 1956:46) indicated that the Scissor-tailed Flycatcher is a "summer resident" in all of Texas but the extreme western part, thus including many counties on the Mexican border, there is no breeding record cited in the Distributional Check-list of the Birds of Mexico, Part II (Pac. Coast Avif. No. 33, 1957), nor have I been able to locate any breeding records for México in other literature.

On the same date and along the same highway, one Scissor-tailed Flycatcher was seen at Km. 1172 in Nuevo León, two at Km. 1179, and one at Km. 1186, the last two localities being in Tamaulipas. On June 19, 1954, these birds were common locally along the highway from central Texas to the border at Laredo, and one was seen just south of Nuevo Laredo, México. Other summer records for México have been reported by Davis (Condor, 52, 1950:138) for several localities south to Tres Palos along

the highway between Matamoros and Ciudad Victoria, Tamaulipas, on July 18, 1949, and by Zimmerman (Wilson Bull., 69, 1957:275) at more northern localities on the same road on three dates in 1955. The Scissor-tailed Flycatcher, therefore, seems to be a relatively common and conspicuous species in this border region, which has been traversed by many ornithologists on their way to and from the tropics. Consequently, I failed to appreciate the significance of the nest at the time and collected neither the nest, young, nor adult. There seemed no doubt that the nest belonged to a Scissor-tailed Flycatcher which was perched a few feet away when first discovered and which remained nearby during the several minutes that I took to inspect the nest. The time was about 8:00 p.m. and after sunset. The nest contained five young with white down on their pterylae and with broad, carinate bills of the flycatcher type. No other adult flycatchers were seen. The nest was six feet from the ground in a tree eight feet high. Low bushes, mostly less than four feet high, predominated on the flat, rather barren, surrounding countryside, where yucca and prickly pear were common.—JERRAM L. BROWN, *Museum of Vertebrate Zoology, Berkeley, California, January 8, 1958.*

**The Sequence of the Songbird Families.**—All families and orders of birds are anatomically very similar to each other, much more so than those of reptiles or mammals, but nowhere is this similarity as great as among the families of songbirds (Oscines, Passeres). Except for the larks (absence of a pessusula) and the swallows (closed bronchial rings) there is apparently no family that can be defined unequivocally by anatomical characters. Many attempts have been made to establish reasonable systems by using characters that show variation among the songbirds. Some authors have used the shape of the bill, others the reduction of the outermost primary, the conformation of the tongue, the development of the central nervous system, the scutellation of the tarsus, the musculature of the jaw, the processes of the bones on the palate, and so forth. None of these characters has found universal favor. The objections are always the same: there is always a hint that the real significance of the character is functional rather than phyletic, and that it arises polyphyletically whenever adaptive needs demand it. The simplest condition is by no means necessarily the primitive one, because specializations and elaborations can be lost again with shifts into different ecological niches (contrary to the so-called irreversibility rule!). Consequently, a morphological series is not necessarily an evolutionary series. Finally, each character or character complex may show evolutionary trends that are different from those of other characters.

To resolve this baffling stalemate there is a continued search for new and more reliable characters. In a recent note, Dr. Wetmore (Condor, 59, 1957:207-209) attributed considerable importance to the form of the head of the humerus, a character also described by Ashley (Condor, 43, 1941:184-195) and earlier authors. In view of the scarcity of other available characters this newly utilized feature is highly important. Unfortunately this character is confronted by the same difficulties as the ones mentioned previously. It may be assumed, with Wetmore (*op. cit.*), that the divided fossa is the derived condition and that it is preceded by a condition similar to that shown in *Corvus*. Yet, a divided fossa occurs also among the gulls and perhaps in other non-passerine groups which surely acquired this feature independently. How many times was this character acquired independently among the songbirds? Even closely-knit groups like the "American Insect Eaters" (*sensu* Zimmer) are heterogeneous for this character; according to Berger (Bull. Amer. Mus. Nat. Hist., 113, 1957:231-272), the fossa is undivided in the Cyclarhidae and Vireonidae, and divided in the other families (with an occasional exception). Among four specimens of *Vireo flavifrons*, Berger found a graded series from the undivided to the distinctly divided condition. In the Old World Insect Eaters, Berger found an undivided fossa among the Pycnonotidae, Laniidae, Sylviidae, and Timaliidae, while the specimens of Turdidae and Muscipidae which he examined had a divided fossa. How often the undivided fossa is a secondary return from a divided condition cannot be determined until the functional significance of these various configurations of the head of the humerus are better understood. It seems that the humeral fossa is no more reliable as a basis of classification than any other single character.

More disturbing is the thought that the entire approach of classifying families of songbirds into "primitive" or "advanced" ones may never lead to an unequivocal answer. It is becoming more apparent from day to day that phyletic lines do not develop as harmonious "types," but rather that most evolution is of the "mosaic type," as DeBeer and others have pointed out. This means that different organs evolve at different rates, some remaining primitive, while others evolve rapidly.

*Archaeopteryx* is a famous example of mosaic evolution; the South African apeman *Australopithecus* is another. However, these are not exceptions, and as far as the songbirds go, one finds a mixture of "primitive" and "advanced" characters in almost every family. It is this fact of mosaic evolution which, perhaps more than any other, is responsible for the divergence of opinion on the arrangement of the families of songbirds into "more primitive" and "higher" ones. Depending on the organ system chosen, whether wing, bill, legs, or brain, a different sequence will emerge.

There is a challenge to weigh the different characters and to use them in combination as the basis of a new system. This has been tried in recent years by Mayr and Amadon (Amer. Mus. Novit., No. 1496, 1951:1-42), Wetmore (Smiths. Misc. Coll., 117, 1951:1-22), Amadon (Proc. Calcutta Zool. Soc., Mookerjee Mem. Vol., 1957:259-268), and Delacour and Vaurie (Los Angeles County Mus., Contrib. in Sci. No. 16, 1957:1-6). Each of these systems makes the explicit or implicit claim to be superior to the others. As mental exercises these proposals are stimulating, and together with many others previously proposed they contribute to the ultimate understanding of avian evolution. Unfortunately, however, this delightful diversity of opinion is not very practical. If the student of the birds of the world opens the pages of a faunistic list, local handbook, or national or international journal, he must be able to remember each of the five or six sequences most frequently used in the world literature. Otherwise he will not know whether to look at the beginning or the end of the songbird sequence when he wants to find the pipits, shrikes, or crows.

This chaotic situation has long been a source of annoyance to working ornithologists. As a result, at the XI International Ornithological Congress at Basel, a committee was charged with the task of proposing a sequence of songbird families that would be acceptable to the majority, and the acceptance of which might lead to uniformity instead of the present chaos. The committee members voted individually on the three sequences most frequently used throughout the world, and all six voting members (Berlioz, Dementiev, Junge, Moreau, Salomonsen, and Stresemann) expressed their preference for the sequence that starts with the Old World Insect Eaters and ends with the crows and birds of paradise.

The reason for their preference was stated by several members of the Basel Committee as follows: it is the sequence most frequently used in the world literature and is no more arbitrary than any other proposed sequence. No claim is made in the report of the committee that the adopted sequence is the best possible system or even a final one. There is no reason why anatomists and other students of avian classification should not continue to make proposals for revision and state their reasons for considering a different arrangement as superior. Indeed, our present knowledge of the comparative anatomy and ethology of passerine birds is still so slight that enormous future progress in our understanding is to be expected. However, until the superiority of a different sequence is clearly established, it would seem advantageous for the ornithologists in the different parts of the world to follow an internationally endorsed sequence. This would surely facilitate communication.

The sequence adopted by the Committee of the International Congress, the so-called Basel Committee, was published by Mayr and Greenway (Breviora no. 58, 1956:1-11).—ERNST MAYR, Museum of Comparative Zoology, Cambridge, Massachusetts, December 5, 1957.

**The Dickcissel in California.**—On November 19, 1957, a bird of sparrow size was taken in one of my banding traps located on the campus of Humboldt State College at Arcata, California. As I was preparing to band the bird I realized that it was of a species unfamiliar to me. It was taken alive to the Wildlife Department at the college where it was identified as a Dickcissel (*Spiza americana*) and added to the Humboldt State College collection.

There was no indication that this individual had been a captive for it was quite wild and in excellent condition, with heavy fat deposits, both subcutaneous and in the body cavity. The bird was a male and was in the typical winter plumage of the species. The black throat patch was almost lacking except for a few black tipped feathers. The chestnut on the wing was very distinctive as was the yellow breast. The bird had evidently entered the trap in quest of the bread crumbs used for bait.

Apparently this is the second record of the species in California. The first record was based on an individual captured in September, 1948, in Santa Monica by Mrs. Norris Kittinger, who released the bird after identification (Condor, 51, 1949:44).—JACK B. WOODY, Humboldt State College, Arcata, California, January 15, 1958.

**A Breeding Population of *Zonotrichia leucophrys gambelii* in the Northern Cascade Mountains of Washington.**—In the open meadows of the area about Hart's Pass, on the summit of the Cascade Mountains in Okanogan County, singing male White-crowned Sparrows are relatively common in late June and early July (Farner and Buss, Condor, 59, 1957:141). I have seen and collected them in this area in the first week of July, 1955, the second week of July, 1956, and during the last week in June, 1957. Prior to this, similar observations were made by G. E. Hudson. An adult male taken by him one mile south of Slate Peak on June 27, 1953 (WSC 53-169), has been identified by Allen J. Duvall as *Zonotrichia leucophrys gambelii*. A singing male (WSC 57-329) which I obtained on July 14, 1956, at the same locality is also obviously referable to this subspecies. During the second week of August, 1956, James R. King, A. C. Wilson, and I spent four days carefully searching these areas; we found no White-crowned Sparrows whatsoever at that time.

The fourteen additional adult specimens which I have taken have been used primarily as sources of materials for our studies of the control of annual cycles and were consequently unsuitable for study skins. However, careful examination of these birds in the field revealed, in each case, the complete white superciliary stripe extending to the base of the bill as is the case in *Z. l. gambelii*. Thus our observations indicate no tendency toward the black-lored pattern of *Z. l. oriantha* as has been reported farther east in southern Alberta (Rand, Nat. Mus. Canada Bull., 111, 1948:95). It is, of course, logical that this tendency should be lacking in the population of Washington since it is not in contact with any population of *Z. l. oriantha*.

On June 29, 1957, Andreas Oksche and I found a nest containing five young, one of which (WSC 57-224) weighed 16.9 grams. The adults, which were seen feeding the young, were used as a source of histologic material for the study of the annual cycle of pituitary activity and hypothalamic neurosecretion. However, both had the typical complete superciliary stripe of *Z. l. gambelii*. The nest was located in a wet meadow at about 6400 feet covered with typical alpine vegetation including scattered dwarf *Salix* which was 30 to 50 cm. high. The nest was about 10 meters from a small clump of alpine firs (*Abies lasiocarpa*) in which both adults frequently perched; it was on the ground in a sparse clump of *Salix* about 30 cm. high. It was constructed mostly of dry grass, the lining consisting of finer pieces. A single long horse hair was also included in the lining. The inside diameter was about 6 cm., the depth about 4 cm. The minimum and maximum outside diameters were 11 and 15 cm., respectively.

These records are of interest with respect to the southern limit of the breeding range of *Z. l. gambelii* since up to this time it has not been found breeding either in Washington (Jewett, Taylor, Shaw, and Aldrich, Birds of Washington State, 1953:647) or elsewhere in the United States (A.O.U. Check-list, 5th ed., 1957:619).—DONALD S. FARNER, Department of Zoology, State College of Washington, Pullman, Washington, December 3, 1957.

## NOTES AND NEWS

At the recent annual meeting of the Cooper Ornithological Society held in Salt Lake City, Utah, the following papers were presented on April 25: The Intermountain Chapter of the Cooper Ornithological Club, by William H. Behle; Bird Remains Collected at Kit Fox Dens, Harold J. Egoscue; Bird Hazard to Aircraft, With Special Reference to Midway Atoll, Johnson A. Neff; Migration Data on the Shorebirds of the San Francisco Bay Region, Junea W. Kelly; Premigratory Changes in Body Weight and Body Fat in Wild and Captive Gambel Sparrows, James R. King and Donald S. Farnier; The Common Screech Owl of the Pacific Coast of Mexico, Joe Marshall; Unusual Occurrences and Distribution of Birds in Utah's West Desert Region, John B. Bushman; The Great Horned Owls of Middle America, Robert T. Orr and J. Dan Webster; The Breeding Behavior of Canada Geese on the Ogden Bay Refuge, Utah, Fant W. Martin.

On April 26: The Role of the Ornithologist in Epidemiological Research, Griffith E. Quinby; Some Relationships of Birds to Arthropod-borne Encephalitis Viruses, Clarence A. Sooter; Experiments on Birds as Hosts of the Western Encephalitis Mosquito, Richard P. Dow; Bird Migration and Disease Transmission, John B. Bushman; Bird Parasites and Life History Studies, D. Elmer Johnson; Los Angeles County Museum's Machris Brazilian Expedition, Jean Delacour; Life History of the Lapland Longspur, Wendell Taber; Life History Notes on the Spurred Towhee, Travis G. Haws and C. Lynn Hayward; Factors Affecting Song Behavior of the Spotted Towhee, John Davis; Interrelations of Abert and Brown Towhees at Tucson, Joe Marshall; The Analysis of Waterfowl Displays, Robert I. Smith; African Safari, Ed N. Harrison.

The field trip to Bear River Migratory Bird Refuge provided an excellent opportunity to observe waterbirds.

The meetings were sponsored by the University of Utah, the Utah Audubon Society, and the Utah Nature Study Society.

## PUBLICATIONS REVIEWED

CHECK-LIST OF NORTH AMERICAN BIRDS. Prepared by a committee of the American Ornithologists' Union. American Ornithologists' Union, Baltimore, Maryland, xiii + 691 pp., 1957. \$8.00 (May be obtained from C. G. Sibley, Fernow Hall, Cornell University, Ithaca, N.Y.).

The publication of the long-awaited fifth edition of the "A. O. U. Check-list" is another milestone in the progress of American ornithology. The new Check-list reflects the great increase in our knowledge of North American birds since the appearance of the fourth edition in 1931. The fifth edition treats in detail 1686 species and subspecies, 266 more than were included in its predecessor. The geographic area covered is the same as in the fourth edition, "North America north of México, with inclusion of Greenland, Bermuda, and Baja California." The systematic arrangement of the previous edition has been retained, with only a few minor changes.

The new Check-list runs to 691 pages, 165 more than the fourth edition, although the list of extinct species which appeared in the first four editions has been omitted, and there is no section summarizing the changes, additions, and eliminations in the present edition as compared with its predecessor, as was included in the fourth edition. The great length of the fifth edition, despite the elimination of these sections, results from the greatly expanded statements of range given for each form. A few comparisons will indicate the extent of this expansion. The range statement for the Franklin's Gull in the present edition is over four times as long as that given in the fourth edition; the statement for the Sanderling is four times as long; and that for the White-throated Sparrow is three times as long. The great amount of added detail and the numerous citations of localities make the statements of range in the present edition much more useful and accurate. The usability of this detailed material is considerably increased by the separation of breeding range, winter range, and accidental or casual occurrences into separate paragraphs; these were lumped in a single paragraph in the fourth edition. A useful innovation is the addition of a general range statement for geographically variable species preceding the more detailed range statements given for the individual subspecies included. Although the section on extinct species has been omitted, fossil records of recent forms are presented in the general statement of range for the species. Another useful addition is the footnote citation of the original description of the nominate form in those cases in which this form occurs outside the area covered by the Check-list.

Vernacular names are given for species only.

Although this departure may cause some confusion it is nonetheless advantageous, as the major emphasis is on the species rather than on the subspecies, and ornithologists will be less prone to think in terms of subspecies unless a critical determination of specimens is concerned. A number of well-established vernacular names has been changed, and some of these changes seem of dubious value.

The treatment of genera and species is largely middle-of-the-road, neither unduly conservative nor extreme. Not considering purely nomenclatural changes, or changes resulting from additional records or the elimination of some older records as invalid, a total of 40 genera has been dropped from the present edition, and three genera not recognized in the fourth edition have been resurrected. A net total of 37 genera has thus been eliminated from the present Check-list. Some inconsistency in the treatment of genera is evident. Thus, *Balanosphyra* is included in *Melanerpes*, and *Antrastomus* is included in *Caprimulgus*. Reference to the pertinent supplements to the Check-list of North American birds, published in the *Auk*, in which these changes were first announced, shows that the authority cited for these changes was Peters' "Check-list of Birds of the World," in which *Balanosphyra* is merely cited in the synonymy of *Melanerpes*, in the one case, and a footnote states that *Antrastomus* is included in *Caprimulgus* in the other. The same basis was used for the synonymizing of a number of other genera. Yet, *Passerella* and *Melospiza* are retained as separate despite the compelling evidence for the merging of these genera brought forth by Linsdale (Univ. Calif. Publ. Zool., 30, no. 12, 1928) some thirty years ago.

On the species level, we also find some inconsistency. Thus, the jays, *Aphelocoma insularis* and *Aphelocoma californica*, recognized in the fourth edition, have been synonymized with *Aphelocoma coerulescens*, although none of these three forms meets any other in any part of its range. On the other hand, the flickers *Colaptes auratus* and *C. cafer*, the orioles *Icterus galbula* and *I. bullockii*,

and the woodpeckers *Dendrocopos arizonae* and *D. stricklandi*, are all retained as full species, although interbreeding between the members of these pairs of species has been demonstrated. It might be argued that the final disposition of such cases awaits a thorough study of the biological situation involved in each case, but this leads to a philosophical question. Where there is some evidence of interbreeding between two dissimilar forms, and the situation involved has not been worked out thoroughly, on whom does the burden of proof rest, those who wish to keep them as separate species, or those who wish to consider them as being conspecific? To urge the retention of such forms as full species until thorough studies have been made, a familiar line of thought, is no more logical than to consider them conspecific "until thorough studies have been made."

In a work of this magnitude, it is inevitable that some errors should occur. One of the worst involves the ranges given for the subspecies of the Elf Owl, *Micrathene whitneyi*. *M. w. idonea* is listed as "resident . . . south to Guanajuato, Valley of México, and Puebla (Tehuacán)," and *M. w. whitneyi* "Breeds . . . south to Sonora (Guicobaca), Guanajuato, México, and Puebla."

Adverse criticism of the new Check-list will be inevitable. Some taxonomists will feel that the committee has been overly conservative, and others will feel that it has been too extreme. The local authority whose record of the Hudsonian Godwit in Popskull County has been overlooked will no doubt be up in arms. But in nearly every case, criticism will involve only a few points, most of them minor. In judging an opus of this scope, one must not lose sight of the forest for the trees. The enormous amount of information and considered judgment contained in this volume make it a tremendously valuable contribution to scientific ornithology, indispensable to amateurs and professionals alike. Ornithologists owe a debt of gratitude to the "Check-list Committee," headed by Dr. Alexander Wetmore, for its devoted and untiring efforts.—JOHN DAVIS.

COOPER ORNITHOLOGICAL SOCIETY  
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS  
FOR THE YEAR ENDING DECEMBER 31, 1957

CASH IN BANK, DECEMBER 31, 1956 . . . . . \$ 7,472.38

ADD: CASH RECEIPTS

*General Publication Fund*

Membership dues, regular and sustaining . . . . .	\$ 5,777.60	
Subscriptions for The Condor . . . . .	1,122.40	
Condor sales . . . . .	439.13	
Phonograph record sales (5 records sold) . . . . .	37.50	
Dividends and interest received on endowment funds invested (Note A) . . . . .	4,351.95	
Contributions received for the publication of The Condor . . . . .	670.00	
Other cash receipts . . . . .	861.85	\$13,260.43

*Avifauna Fund*

Avifauna sales, net (Note B) . . . . .	\$ 3,795.43	
Contributions received . . . . .	7,750.00	
Other cash receipts . . . . .	52.56	11,597.99

*Endowment Fund*

Life memberships and installment payments received on life memberships . . . . .	1,065.00		
Contributions received . . . . .	225.00		
Other cash receipts . . . . .	173.50	1,463.50	26,321.92
			33,794.30

DEDUCT: CASH DISBURSEMENTS

*General Publication Fund*

*Publication Costs of The Condor*

Printing . . . . .	\$ 8,334.82	
Engraving . . . . .	1,594.52	
Purchase of back issues . . . . .	11.95	\$ 9,941.29

Cost of phonograph records . . . . .		1.56
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*Administrative Expenses*

Northern division . . . . .	\$ 108.22	
Southern division . . . . .	95.10	
Annual meeting . . . . .	887.62	
Business manager . . . . .	278.37	
Accounting . . . . .	150.00	
Treasurer . . . . .	620.33	
Editor . . . . .	714.25	
Other disbursements . . . . .	89.09	2,942.98

*Avifauna Fund*

Sales tax . . . . .	\$ 12.54	
Drawings . . . . .	415.00	
Printing . . . . .	2,964.67	
Engraving . . . . .	602.71	
Shipping and Postage . . . . .	428.34	
Other disbursements . . . . .	94.98	4,518.24

*Endowment Fund*

Purchase of corporate stock . . . . .	\$ 5,238.31	5,238.31	22,642.38
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CASH IN BANK, DECEMBER 31, 1957 . . . . . \$11,151.92

	December 31, 1956	December 31, 1957
CASH IN BANK ALLOCATED TO FUNDS AS FOLLOWS:		
General Publication Fund . . . . .	\$ 5,345.10	\$ 2,025.03
Avifauna Fund . . . . .	2,047.14	9,126.89
Endowment Fund . . . . .	80.14	
TOTAL . . . . .	\$ 7,472.38	\$11,151.92

Note A: At December 31, 1957, the business manager had in his custody endowment funds invested in corporate stocks which cost \$50,978.62 and had a market value of \$89,064.63. This endowment fund includes contributions received in the names of Florence M. Bailey, Louis B. Bishop, Albert E. Colburn, Joseph Grinnell, A. Brazier Howell, Harry R. Painton, and Isabel A. Thomson.

Note B: At December 31, 1957, the Society had a stock of Avifaunas for which the total of quoted list prices was \$37,493.00.

C. V. DUFF, *Business Manager*



**For Sale, Exchange, and Want Column**—Each member of the Cooper Society is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line. Send advertising copy to Jack C. von Bloeker, Jr., Los Angeles City College, 855 N. Vermont Ave., Los Angeles 29, California.

**FOR SALE**—We have the following ALL NYLON mist nets available: 60 denier, 2-ply, 1½-inch mesh, 7 feet wide—no. 1, length 18 feet, \$2.00; no. 2, 30 feet, \$2.50; no. 3, 42 feet, \$3.00; no. 4, 60 feet, \$4.00. SPECIAL: no. 2X soft nylon, 1½-inch mesh, 7 × 30 feet, very full for maximum capture, \$4.00. 110 denier, 2-ply, 2¾-inch mesh, 7 feet wide—no. 5, length 18 feet, \$2.25; no. 6, 30 feet, \$2.50; no. 7, 42 feet, \$3.75; no. 8, 60 feet, \$5.50. 210 denier, 2-ply, 4-inch mesh, 7 feet wide—no. 9, 18 feet, \$1.75; no. 10, 30 feet, \$2.25; no. 11, 42 feet, \$2.75; no. 12, 60 feet, \$3.75. We recommend no. 1 through no. 4 and no. 2X for catching small birds, no. 5 through no. 8 for medium-sized birds, and no. 9 through no. 12 for large birds. Special net for ducks, large shorebirds, etc.: no. 15, 12 feet wide, 60 feet long, 4-inch mesh, \$12.50. Please include your Federal Bird Banding Permit Number when ordering nets. California orders must include 4% sales tax. If payment is sent with order we will pay the postage.—BLEITZ WILDLIFE FOUNDATION, 1001 North McCadden Place, Los Angeles 38, Calif.

**UNUSUAL SERVICE**—Unique in fact, is the pre-servicing we give our low-priced binoculars (\$29.50 to \$39.50) in our famous Repair Shop. We reject any with optical or structural defects, tighten loose parts, and align each to United States Government specifications. Equally unusual is our pre-servicing of our Grade A Japanese binoculars: Besides "tuning-up" the alignment to the same standard, we extend the focussing range of six models so you can focus them to as close as 8 to 12 feet! Even more unusual is our 'scope contribution: On the Bausch and Lomb Balscope, Sr., we install a threaded boss for mounting the 'scope directly on a tripod—no adapter needed—no extra cost! Also, we have the answer to every 'scope user's dream: A wide-field 20X eye-piece with 100 per cent more viewing area than the standard-field 20X eye-piece; also rotating turrets. All instruments—irrespective of price—with our FREE-SERVICE GUARANTEE and a 30 days' trial. Many more interesting details; send for free price list and complimentary copy of our "Know Your Binoculars," 12-page booklet reprinting our articles published in Audubon Magazine.—THE REICHERTS, *Mirakel Optical Co.*, 14 W. First St., Mount Vernon 15, N.Y.

**WANTED**—Elton, Mice, Voles and Lemmings—I will pay \$20.00, or you name your price.—HENRY E. CHILDS, JR., *Cerritos Junior College*, 11442 E. Alondra Blvd., Norwalk, Calif.

**WANTED**—Hochbaum, Canvasback on a Prairie Marsh—Please state price and condition.—CLIFFORD V. DAVIS, *Dept. of Zoology and Entomology, Montana State College*, Bozeman, Mont.

**WANTED**—Preserved avian specimens, just hatched, all species, identified, maximum 12 hours old.—DAVID K. WETHERBEE, *Pomfret Center*, Hampton, Conn.

**FOR SALE**—The "Tiny Tucker" Hummingbird Feeder, with instructions for use, \$1.15 postpaid. All profits from sales of these efficient feeders, now equipped with a special bee guard, are used in maintaining this wildlife sanctuary.—TUCKER BIRD SANCTUARY, Box 53, Star Route, Modjeska Canyon, Orange, Calif.

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**FOR SALE**—*Traite de Zoologie*, XV, Oiseaux; binding slightly damaged, \$12.00.—HENRY E. CHILDS, JR., 15053 Nearree St., La Mirada, Calif.

**WANTED**—Pacific Coast Avifauna No. 4, Swarth, Birds of the Huachuca Mts., Arizona; Bulletin of the Cooper Ornithological Club, vol. 1, nos. 3-4; Condor, vol. 2, no. 6, and vol. 3, no. 2. Please state price.—JACK C. VON BLOEKER, JR., *Los Angeles City College*, 855 N. Vermont Ave., Los Angeles 29, Calif.

## PREPARATION OF MANUSCRIPTS FOR THE CONDOR

Articles published in the Condor normally are written by members of the Cooper Ornithological Society. Practically all the Society's money goes into the journal; no editor or business manager receives any pay other than the satisfaction of doing a service worthily. The preparation of good copy by the author will contribute greatly to accuracy of published output, dispatch in handling, and economy of production.

To be acceptable for inclusion in the Condor, articles must not duplicate in any substantial way material that is published elsewhere. Any type of subject bearing on birds may be considered; but the geographic areas of primary concern are western North America, Central America, and the Pacific Basin. Manuscripts may be sent to the editors at the Museum of Vertebrate Zoology. Proofs with edited manuscripts will be sent to authors, at which time reprints may be ordered.

In the interests of accuracy and economy, observe the following: do not duplicate data in text, tables, or charts; check citations to original sources and verify text references; quoted statements must be exact replicas of the original; use vernacular names applicable to the entire avian species (for a guide in this regard, consult the A.O.U. Check-list of North American Birds, Fifth Edition, 1957; insert scientific names for species but not the subspecific name except in taxonomic papers or where the race concerned has been critically determined by the author or his collaborators on the basis of specimens; revise the manuscript repeatedly to remove superfluous words and phrases, immaterial detail, and repetitious statements.

Note Condor style and usage. "General Articles" and the "Field and Study" items are set up in different form. Provide a concise, meaningful title, and, where needed, subtitles within the text. Footnotes are not used. The address line may serve to indicate institutional connection, and to it should be added the date of transmittal of the manuscript. Terminal bibliographies are usually desirable where five or more titles are to be cited; otherwise, the references may be included in the text. For bibliographic style, note closely the practices employed in recent volumes of the journal. A factual summary is recommended for longer papers.

Rules for copy.—(1) Typewrite material, using one side of paper only; (2) double space all material and leave liberal margins; (3) use  $8\frac{1}{2} \times 11$  inch paper of standard weight (avoid onion skin); (4) carbon copies are not acceptable; (5) place tables on separate pages and plan them to fit normal page width; (6) number pages in upper right hand corner.

Illustrations.—Photographs should be glossy prints of good contrast. Make line drawings with India ink; plan linework and lettering for at least  $\frac{1}{2}$  reduction; do not use typewritten labels on the face of the drawing. Provide typed legends on separate sheets.

Helpful references on writing: Manual of Style, University of Chicago Press, and Rules of the Editorial Committee, University of California Press. On scientific nomenclature: Fifth Edition of the A.O.U. Check-list, The Distribution of the Birds of California (Pac. Coast Avif. No. 27), and The Distributional Check-list of the Birds of Mexico, Parts I and II (Pac. Coast Avif. Nos. 29 and 33); authors are not required to follow the nomenclature of these works.

